The Bulletin

ol. 40 no. 2 Summer 2015 www.bvws.org.uk

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Bulletin of the British Vintage Wireless Society
Incorporating 405 Alive
Volume 40 No.2 Summer 2015

www.bvws.org.uk

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Front and rear cover: Various valves from the Droitwich Room at The British Vintage Wireless and Television Museum, West Dulwich, London.

Photographed by Carl Glover
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Proof-reading by Mike Barker and Steve Sidaway

Contents

From the Chair

BVWS Awards

The 2014 Pat Leggatt Award for best Bulletin article voted for by the membership was presented to J. Patrick Wilson for "Test Sets & Multimeters" part of a series of articles entitled "How do they work?" The 2014 Geoffrey Dixon-Nuttall Award for best restoration article was presented to Simon Tredinnick for his most interesting "EMI Component Bridge Q.D.211" restoration feature.

BVWS DVD

With the Spring 2015 issue of the Bulletin you should have received a most interesting DVD of vintage radio & TV related material. Some of the Material is very rare and by no small amount of hard work and hours at the computer, was brought back from the realms of unwatchable to the enjoyable state you see it in today by Jon Evans. We hope you liked it. Thank You Jon! The Next BVWS DVD production is well under way and will be included with the Winter Bulletin. The Committee would like to thank Richard Stow, Phil Marrison and Tony (M0SHA) for giving us access to this archive material.

Gerry Wells Memorial event

On the 6th June there will be a Celebration of the life of Gerry Wells at the British Vintage Wireless & Television Museum. The event is open to everyone and is free. With a mid-day start running until 6pm there will be plenty of time to have a really good look around the Museum. There has been a great deal of hard work going on to make the required changes to the Museum display galleries so expect quite a few differences. There will be scheduled tours as well as just being open to view.
This will not be a solemn event but more of a jolly London style Knees-Up with plenty of music chosen by Gerry for his past Garden Party recordings (sing along if you wish) with a few old favourites thrown in. Part of the afternoon will be given over to showing a number of Gerry's Film and TV appearances and then to complete the afternoon the Museum DJ's will be spinning the 78's on the WADAR (Wells Amplifier Developments And Rentals) holiday camp console. Bring along a Picnic to enjoy in the garden.

Cinema Museum event

I am looking forward to the combined BVWS and Cinema Museum event. It promises to be a most interesting day with a lot of vintage radio, Hi-Fi and TV equipment. The Cinema Museum will be fully open to all visitors and there will be film shows running in the auditorium. They will also be disposing of a quantity of surplus Cinema/Audio equipment. The BVWS table will be there with plenty of stock from the store and the usual Capacitor stocks etc.

At the last BVWS AGM I made an announcement that caused a bit of a stir. I have decided to resign my position of Chairman and Committee member at the 2019 AGM. By this time I will have been on the Committee for some twenty five years and will have been Chairman for twenty years. From this point onwards I will be handing over some of the jobs that I do to others and working on a plan for the BVWS future so that when I hang up my coat there should be practically no effect on the running of the Society. I will remain the Society Auctioneer and continue with all collections, auctions etc. I will also continue to run the sales of publications and capacitors etc. at some of the meetings as I do now so you will still see me at all events. But for now it is Business as usual and lots of work to do as next year we will be celebrating our 40th anniversary.

Mike…

Vintage radios spotted in Spanish Warehouse

BVWS member Loius Coakley and his wife discovered a warehouse in Funchaz, Madeira filled with used trade items containing a significant amount of vintage wireless sets ranging from the 1940s - 60's. He ended up purchasing a Tesla 307U from 1953, which can be seen in the picture below on the left.

A tale of two hybrids - The Emerson 838 and the Marconiphone P60B compared

by Stephen Niechcial

The claim to be the world's first production model all transistor radio goes to the American Regency TR-1 in 1954. However, it was very expensive at nearly $50, and didn't perform very well. A variety of problems with early transistors meant that all-transistor radios got off to a slow start.

Left: Fig 1. The three valves as fitted in the Emerson. On the left as supplied new, on the right as trimmed to fit the in–line holders.

Below: Fig 2. Three American valves fit in the space of one European one

In particular, the first transistors suffered from frequency-gain limitations which made them problematic for use in H.F/I.F. stages. Industrial production of transistors was also very random with wide variations in gain and noise for a given type. This meant that individualised testing and selection of devices was necessary for applications; a time costly business acceptable to the world of cutting edge military hardware, but problematic in the competitive world of domestic radio production. Nonetheless, radio manufacturers could see the way the future was going, and they were also keen to cash in on the latest marketing ploy by being able to put 'Transistor' on the front of their sets. The solution adopted by many of them between 1955 and 1960 was to produce hybrid valve transistor receivers, commonly with three miniature valves in the HF/IF/detector stages followed by transistors for audio output. However, from this initially slow start, transistor development became very rapid, with the result that within a couple of years all-transistor designs were economically viable. So manufacturers generally produced hybrid sets for a period of eighteen months at most, with the result that they are now comparatively rare.

About four years ago, Stef Niewiadomski came across an Emerson 838, an American hybrid from 1955, and wrote it up for this magazine. Stef didn't want to repair it himself, so for a donation to the Vintage Wireless Museum it passed to me. Last year I came across a British hybrid - a Marconi P60B from 1958 (also marketed as the HMV 1410) and restored that, so I thought it would be interesting to compare the two projects.

General features.

A quick glance at the circuit diagrams below tells you that these two sets have a great deal in common. Both are superhets (Emerson 455Khz, Marconi 470Khz), although the Emerson, being designed for the single AM. waveband American market has no LW/MW switching. Both use three valves up to the detector, followed by two PNP germanium transistors working in push-pull and driven by a centre tapped transformer in the audio stages. In each, a portion of detected

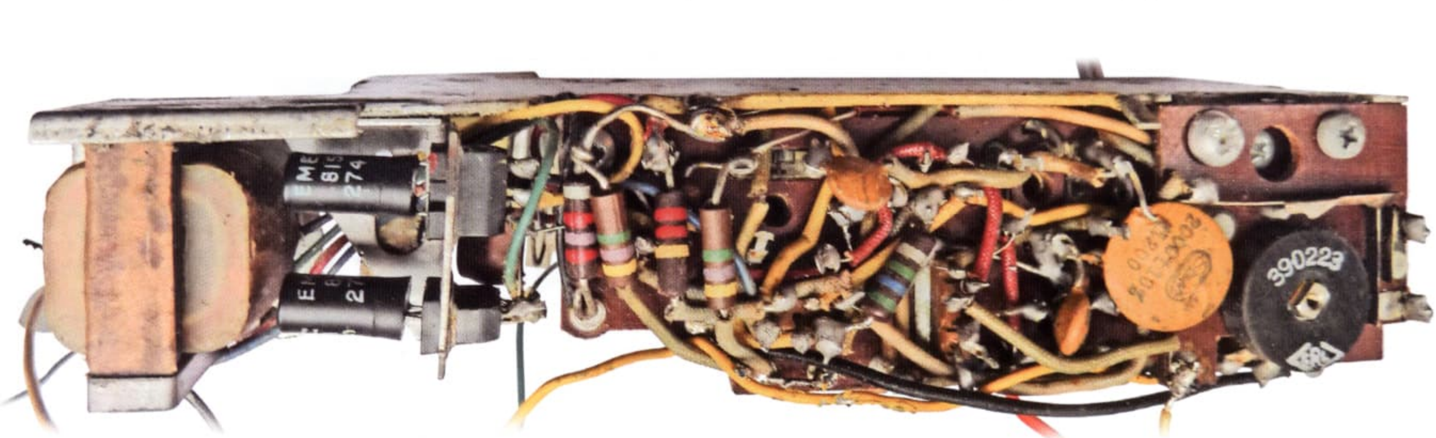


Fig 3. Showing impossible to dismantle overlay of components. New–fangled double pole skeleton on–off volume control on the right, transistors on left

audio is smoothed and use as an A.G.C line operating on the control grid of the R.F. amplifier only. Each of them has the valve heaters in series with the 4.2 / 4.5 volt heater battery doubling as the supply for the transistors. Apart from their transistors, the sets have some other 1950s 'state of the art' features, namely their ferrite rod aerials, use of ceramic capacitors, miniature I.F. transformers and plastic cabinets. The Marconi is also built on a tinned copper printed circuit board (the Emerson is point to point wired), and the Emerson has a futuristic composite component in the form of four ceramic capacitors moulded into a block as a single component (shown as C9, a, b, c & d on the circuit diagram).

The immediate and striking difference between the two sets is their physical size. The speaker in the Marconi is actually smaller than that in the Emerson by about half an inch but its cabinet is three times larger than that of the Emerson (7.25 x 5.25 x 2.5 inches, 95 cubic inches - versus 6 x 3.5 x 1.5 inches, 31.5 cubic inches). With batteries, the Marconi weighs in at 1.272 Kg, and the Emerson only half of that at 0.624 Kg. Apart from bigger and therefore much longer lasting batteries, the extra bulk of the Marconi gives it absolutely no performance advantage. I have no doubt that the Emerson would have been even smaller and lighter had the modern miniature solid dielectric tuning capacitor been available. As it is, a chunky air spaced tuning capacitor takes up almost a quarter of the component space on its chassis.

Valves

The American industry went one stage further than the British in the miniaturisation of domestic receiving valves. All three of the valves in the Emerson actually take up less space than one of the 96 series valves used in the Marconiphone. This is the principal reason why Emerson were able to go so small (Figs. 1 & 2). As far as I can make out, the American valves first appeared on the scene in 1951- a couple of years ahead of the 96 series. In contrast to the 96 series, the American valves are specifically designed to work on lower HT lines (around 45V), their nominal heater requirement is 1.25 V at 40 mA (50mW) compared to the 96 series of 1.4V at 25mA (35mW). As can be seen from the photo, the American valves are supplied with long leads which enable them to be soldered in directly, or as in the Emerson, cut down to 3mm. to plug into an in-line base. The 1AH4 pentode I.F valve (Fig. 1, second from left) is metalised.

Fixing the Emerson.

A quick check across the L.T and H.T battery connections revealed O/C across the heater chain- fortunately no more than a dirty on/off switch (phew). Restoring that and connecting up bench supplies brought a 'click' from the speaker when switching on, but no more. Hooking up a 'scope showed the front end was oscillating with a good I.F signal going into V3 (1AJ5), but nothing coming out. At this point, I noticed the H.T. current was much higher than it should have been, and re-measuring the H.T resistance to chassis came up with about 2K, which is roughly the value of the V3 anode load, T1 primary. Oh dear - yes indeed, V3 anode was internally shorted to chassis. In a state of mild depression I removed it and gave it a sharp tap, and wonder of wonders it cleared! At least for a few minutes during which time the set burst into loud and healthy voice before dying again. Being a born pessimist I thought I would never get a replacement, but two minutes on–line located a complete set of 'new old stock' valves at Tube Depot in the U.S.A for just a few dollars. Where would we be without the Web? A couple of weeks later, replacement valve fitted, valve bases and volume control cleaned, the set was really in no further need of attention. Tweaking of IFs and trimmers showed they were already spot on.

There are a few paper capacitors in this set as well as a couple of electrolytics, all of which I would normally have replaced as a matter of course. However if you look at the 'underside' of the chassis (Fig. 3, which is actually the uppermost side because it is mounted upside down) you can see that the construction is impossibly awkward with components layered on top of other components. Trying to change any caps. would have meant unsoldering, or probably snipping, many other bits to get to them. Fortunately they didn't seem to be broke, so I didn't try to fix 'em.

The ferrite rod aerial on this set is concealed in the sloping top of the case and is held in its compartment permanently by a piece of paxolin which is heat fused into the plastic case and not meant to be

Fig 4. Aerial compartment cover. Ground plane or Shield

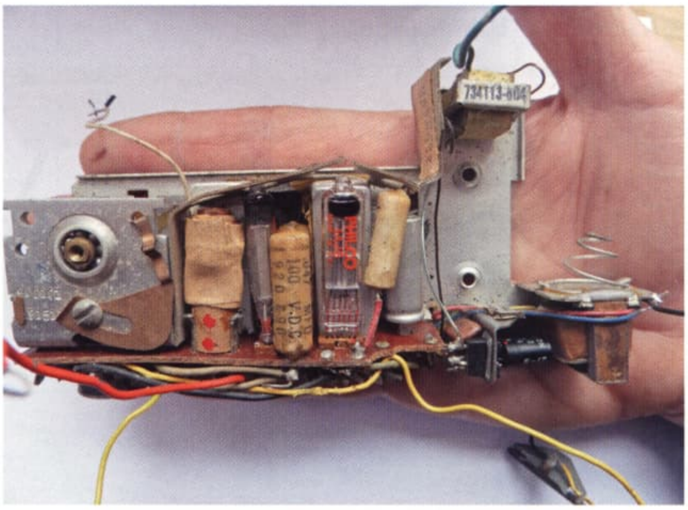


Fig 6. Emerson chassis front view with speaker removed. Transistors and driver transformer bottom right, with output transformer above

Fig 7. HT battery holder made from a cut-down AAA holder

removed, so the aerial leads have to be unsoldered from the chassis before the latter can be removed. Unfortunately, in the course of work one of the wires from the aerial compartment fell off requiring me to remove the paxolin to resolder. The piece of paxolin turned out to have a printed copper pattern on it, connected to chassis via the piece of wire which had fallen off (Fig. 4). I've no idea exactly what purpose this serves. Some kind of ground plane or screening for the aerial? Any ideas welcomed. Another feature of this aerial in the case is that its lead outs are very short which makes it impossible to align the set with the chassis out of the cabinet. To get round this, the manufacturers provided a removable plastic hatch on the side of the cabinet which allows access to the tuning gang trimmers.

Fabricating replacement batteries for the long obsolete Emerson ones presented a challenge. My general approach to this problem is to fill up as much of the original battery space as possible with batteries so as to maximise the time between changes, also to use batteries which are not too esoteric and expensive if at all possible. The Emerson's original batteries were a an ordinary layer type H.T battery of 45V and a cylindrical mercury battery of 4.2V. The H.T. battery space was almost exactly the profile of the 15V battery that goes in the older model of Avometer. Three of those pushed up against each other in series would have been ideal. Unfortunately,

Fig 8. Emerson 838 – the finished set

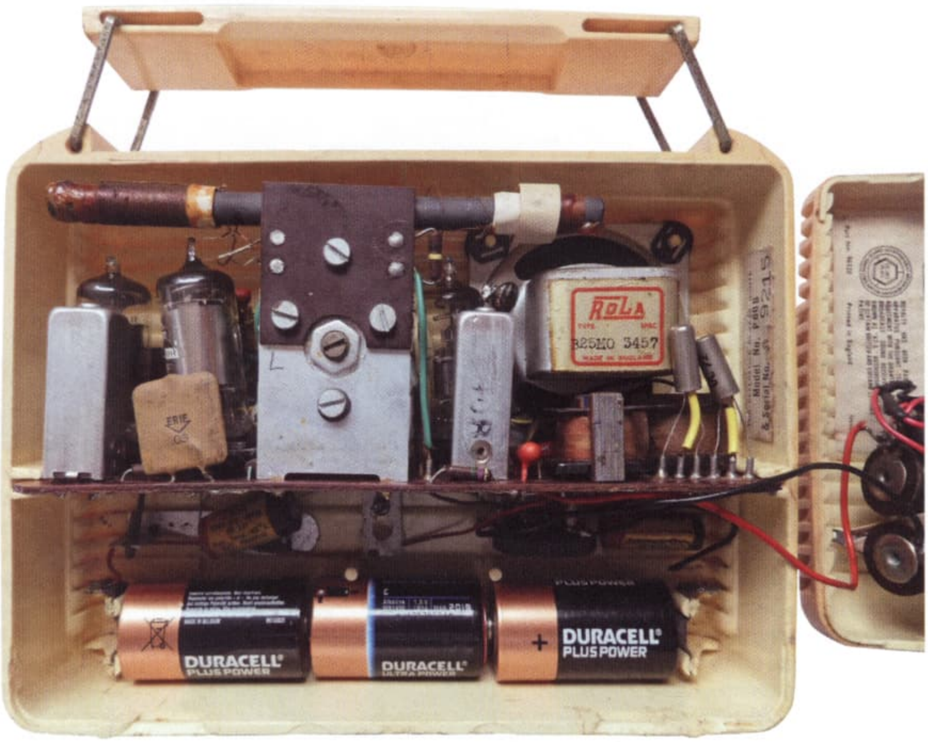


Fig 9. The Marconi- a bank of PP3 batteries just fits under the PCB

the whole battery compartment was too short by about a centimetre, so back to the drawing board. The best I could come up with was using four 12V MN21/23 batteries in series to give me 48V. These batteries are small low capacity ones designed for use mainly in car remote key fobs. A look at the data sheets shows surprisingly that their rated capacity actually varies considerably between manufacturers. The HT current specified on the service and measured in practice is 2.5 milliamps. Using a variable power supply to experiment gave me a reasonable level of volume down to about 20V. The sound becomes inaudible at about 12V, though the scope shows that V1 goes on oscillating to below 10V. Using these figures I reckon getting about eight usable hours out of a set of batteries- well down on the 50hrs+ the original would have delivered.

The MN21/23 batteries are the same diameter as an AAA, but quite a bit shorter. The HT battery compartment would have taken an AAA battery holder of the type where you have two AAAs in line with each other alongside two other AAAs in line with each other. Believe it or not, though this type is common for AAs it does not exist for AAAs, so I had to cut and stick together a couple of two cell AAA holders as per Fig. 7. The original battery has a PP3 type connecting clip as does the new arrangement, so no modification to the set necessary. The whole arrangement is not particularly good, as these batteries are expensive, and there is empty unused space in the H.T. battery compartment, but it is the best I have been able to come up with so far. The situation with the L.T. battery was a bit easier. The compartment will just take one of those new type battery holders you often see in LED torches. These fit three AAA cells in series round a plastic drum, giving you a holder which is only fractionally longer than a single AAA. On-line again, and Ebay turned up a supplier from China selling them at just over three quid for five, postage included! The three series wired valve heaters are each rated at 1.25V, 40 mA. To prevent overloading then from my 4.5V supply I inserted a small silicon diode in series which drops the voltage down to about the required 4V. The transistors add about another 10 mA. to bring total L.T consumption to 50 mA., which means that good quality AAAs of about 1100 milliAmpere hours should give me over 20 hours usage.

The plastic cabinet of this set has many war wounds with which I could do little, so the whole job electronically and cosmetically has finished more as a repair than a restoration. The set came to me with the tuning knob missing. I've managed to borrow one, but need to fabricate a replacement. The answer maybe to go high-tech and get one 3D printed. The completed set is as at Fig.8.

Cold war chill

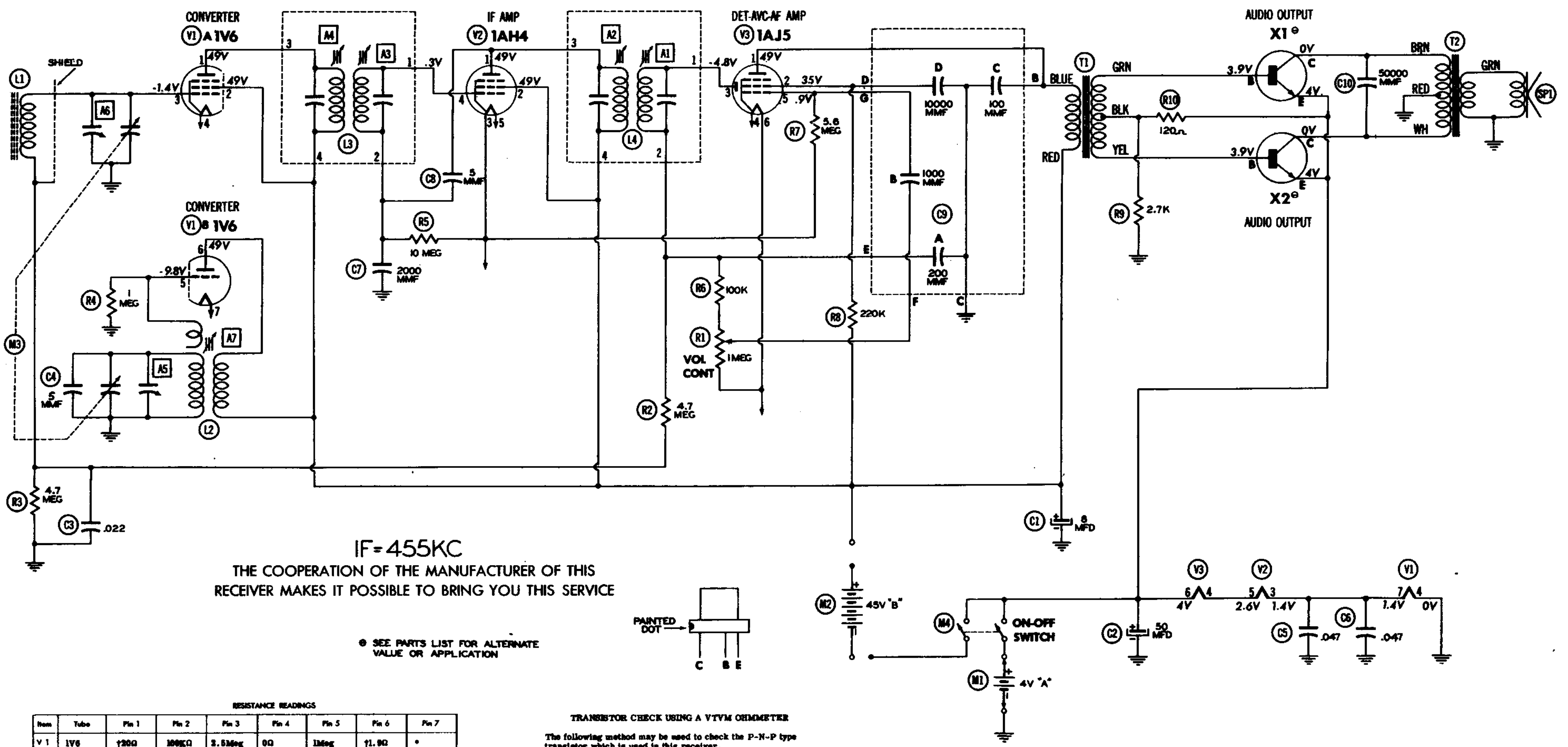
I was very puzzled by the adjustable piece of copper mounted on the front face of the tuning capacitor as visible in Fig 6. The ridge visible on the copper engages with a hole in the back of the tuning knob to give a click in pre-set station position. Going on the wonderful Web again, I turned up a copy of the original radio instruction book which revealed the mystery. The instructions say:

'This receiver is equipped for use as a CONELRAD CIVIL DEFENSE RECEIVER'.

Conelrad stands for CONtrol of ELtromagenetic RADiation and was part of the contemporary US defence against attacking Soviets homing in on American broadcast transmitters to guide nuclear bombers and missiles. The idea was that in the event of an emergency, all transmitters would be shut down and emergency instructions broadcast to the public on one of two frequencies - 640Khz or 1240Khz. The system on the Emerson is there to enable the user to preset either of these frequencies as appropriate. A chill ran down my spine when I read that; it really brought home to me just how real and close the threat of nuclear annihilation must have felt to people at the time.

Fixing the Marconi.

Being altogether more spaciously constructed and accessible (Fig. 9), I expected a much easier job with the Marconi than with the Emerson. Sadly not so! Connecting up power gave much the same results as with the Emerson - a 'click' from the transistor output stage, but nothing else. The first challenge on this set is to get test equipment connected! Clearly, Marconiphone were taking no chances with these first generation printed circuit boards. As well as being tinned, this one is clear varnished for further corrosion protection. The covering is completely invisible until you look very closely which caused me much puzzlement initially as I couldn't get any



IF=455KC

THE COOPERATION OF THE MANUFACTURER OF THIS RECEIVER MAKES IT POSSIBLE TO BRING YOU THIS SERVICE

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RESISTANCE READINGS

Item	Tube	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7
V 1	1V6	†20Ω	100KΩ	2.5Meg	0Ω	1Meg	†1.9Ω	*
V 2	1AH4	†20Ω	100KΩ	*	10Meg	*		
V 3	1AJ5	†2.3KΩ	†220KΩ	1Meg	*	5.6Meg	*	
		Base	Emitter	Collector				
X1	Transistor	44Ω	40Ω	8.4Ω				
X2	Transistor	44Ω	40Ω	8.4Ω				

† MEASURED FROM POSITIVE SIDE OF C1.
* DO NOT USE OHMMETER TO MEASURE FILAMENT RESISTANCE.

TRANSISTOR CHECK USING A VTVM OHMMETER

The following method may be used to check the P-N-P type transistor which is used in this receiver.
CAUTION: Use only a VTVM ohmmeter and connect a 1000Ω resistor in series with either lead.
1. Set meter switch to RX10 position.
2. Connect one meter lead to the base - connect the other meter lead to the collector. Note meter reading.
3. Reverse meter leads. Note meter reading.
4. After subtracting the 1000Ω series resistance initially added, one reading should be 500Ω or lower, the other reading, 50000Ω or higher.

1. DC voltage measurements taken with vacuum tube voltmeter;
2. Socket connections are shown as bottom views.
3. Measured values are from socket pin to common negative.
4. Nominal tolerance on component values makes possible a variation of ± 15% in voltage and resistance readings.
5. Volume control at maximum, no signal applied for voltage measurements.

A PHOTOFACT STANDARD NOTATION SCHEMATIC

311-4

Emerson 838 circuit

readings off any connection. The varnish was an ongoing pain. I found the easiest way in the end was to melt the solder on each connection I wanted to measure on.

This time, the 'scope showed oscillation on V1 (DK96), but nothing on the anode of V2 (DF96). Sadly, the primary of the first IF transformer was O/C. Gently taking it apart showed that it wasn't something simple like a corrosion at the winding ends, so it was off to Mike Barker for a rewind. Mike contacted me to say that the winding was of an unusual structure that he couldn't reproduce exactly. Apparently instead of the usual Litz wire, each winding was wound with three separate, parallel and very fine wires laid down simultaneously. Mike said he would have to rewind in Litz and cautioned that I might lose some Q.

On refitting the transformer, there was now voltage at the anode of V2, but no signal on the scope. Mike had aligned it to IF frequency, so I knew it couldn't be far out, and indeed, slight adjustment of the cores each way still produced no results. Going back and looking more closely at the signal on the mixer anode, I realised it was not at all what it should be. Sweeping the tuning gang, it varied wildly in amplitude, at points vanishing altogether or breaking into instability. Clearly something was amiss at the front end. To cut a long story short, the D.C resistance of the primary of the first IF transformer turned out to be about half of the service sheet figure. So back to Mike for another rewind. Luckily the two IF transformers are identical, so having worked out the turns on the first one, the second was an easier job. This was the first partially shorted IF transformer I've come across on a 50s portable, but I've come across several o/c ones on otherwise dry and un-corroded sets, which has always puzzled me. Mike explained that the problem is common in compact case portables using valves due to the batteries giving off corrosive gases in a confined space.

First I.F transformer replaced, the set now responded with weak signals on both wavebands. Before proceeding further I went through the procedure for setting the bias current on the output transistors. This involves setting different currents depending on room temperature, and shows just how critically idiosyncratic these early production transistors were.

To cut a very long story short again, much more fault finding, valve/component substitution and re-alignment did not improve results from the set greatly. Although all transformers and trimmers had fairly sharp peaks, indicating nothing seriously amiss on circuit tuning, the gain and sensitivity remained well below that of the Emerson, and indeed well below that of comparable contemporary sets using the 96 series of valves. Whether this is a problem of original design, or loss of IF transformer Q as Mike warned I don't know. I would be pleased to hear from anyone else who has got experience of these sets.

Battery provision was an absolute doddle compared to the Emerson. The L.T. supply consists of three U11 batteries, better know to us as the C cell, and still of course readily available. With a combined heater plus transistor current of only 35 m.A. and the best alkaline batteries, I can expect about 140 hrs before replacement. The HT battery space nicely takes eight PP3s giving 72v against the specified 67.5V, and best quality ones will last for about 200 hrs.

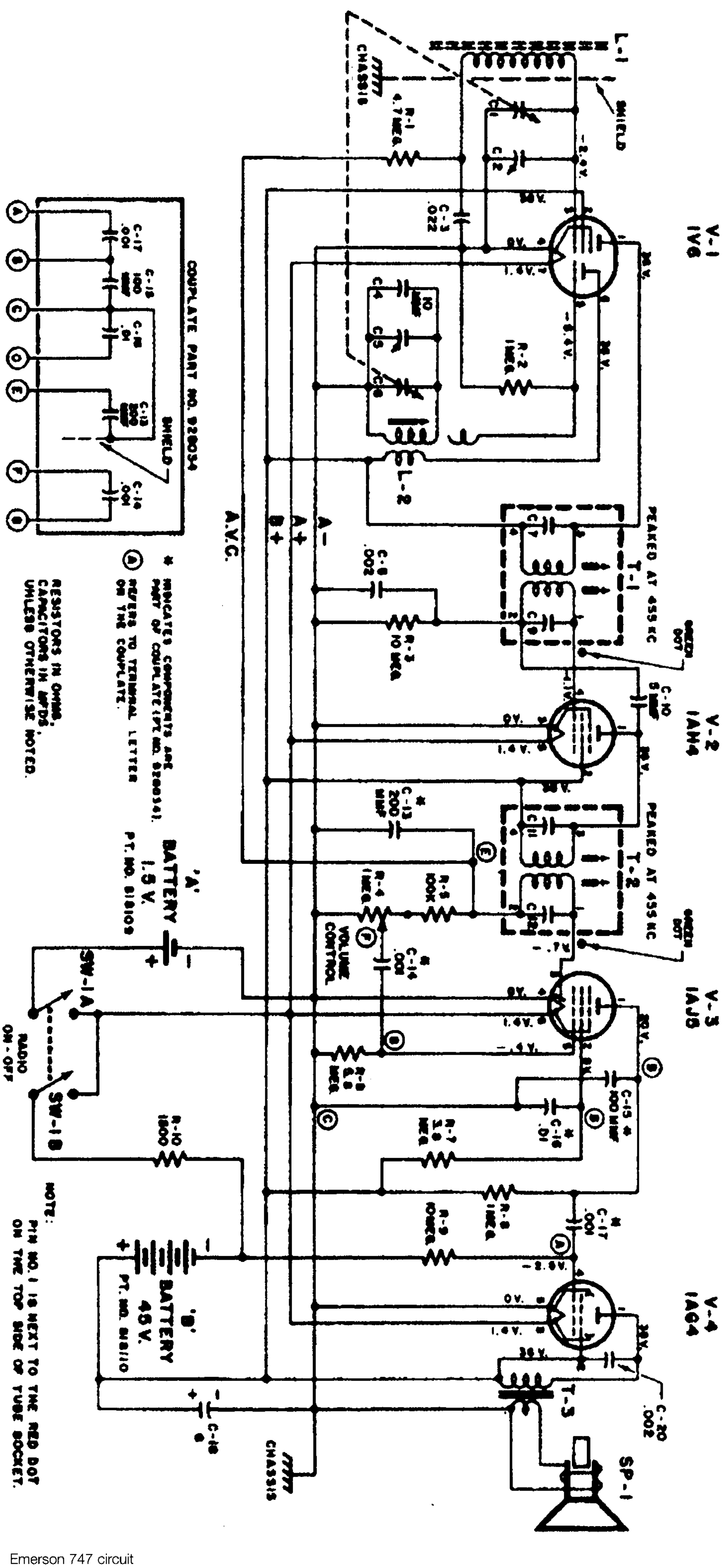
The case of this set (Fig. 10) is in pretty reasonable condition. It has faded fairly uniformly from its original light yellow (as evidenced behind the tuning knob), to a dullish cream.

Fig 10. The Marconi set

Fig 11. The Invicta model 30, early British 'all transistor' radio

Were hybrids worth the effort?

From the manufacturer's point of view they undoubtedly were because they allowed them to gain experience in the mass production use of transistors. Every age also has consumers willing to pay a premium price to be the first with the latest technology, and sticking a couple of transistors in the output stage allowed Emerson to market it as a 'Transistor' radio. But what about the consumer, was the hybrid technology worth it from his/her point of view?



Emerson 747 circuit

In the case of the Emerson it's possible to answer this by direct comparison because the 838 is a direct development of the 747 receiver of the year before. In fact the two receivers are identical in almost every way, having only two differences between them. The first is that the four valves of the 747 are wired in parallel instead of series, and hence require a 1.5V battery instead of the 4.2V of the 838. Both these batteries are the same size- an important point I will come back to later. The second difference is of course that the two transistors of the 838 are replaced in the 747 by a valve output stage using the 1AG4 valve. So comparing them what do we get? Well obviously in terms of selectivity and sensitivity they must be the same because they are the same set up to the output stage. They both have the same small speaker which is probably the limiting factor in terms of distortion and output power, I certainly don't hear any distortion additional to that of the small speaker, so probably as far as volume and quality go they are on par. When it comes to component count however, the 838 is at a disadvantage needing an additional driver transformer putting up weight and cost. Was the transistor output stage more reliable then the valve one? I don't know, but Emerson avoided the mass production problems involved in soldering delicate transistors by plugging them into sockets.

Power consumption and battery life

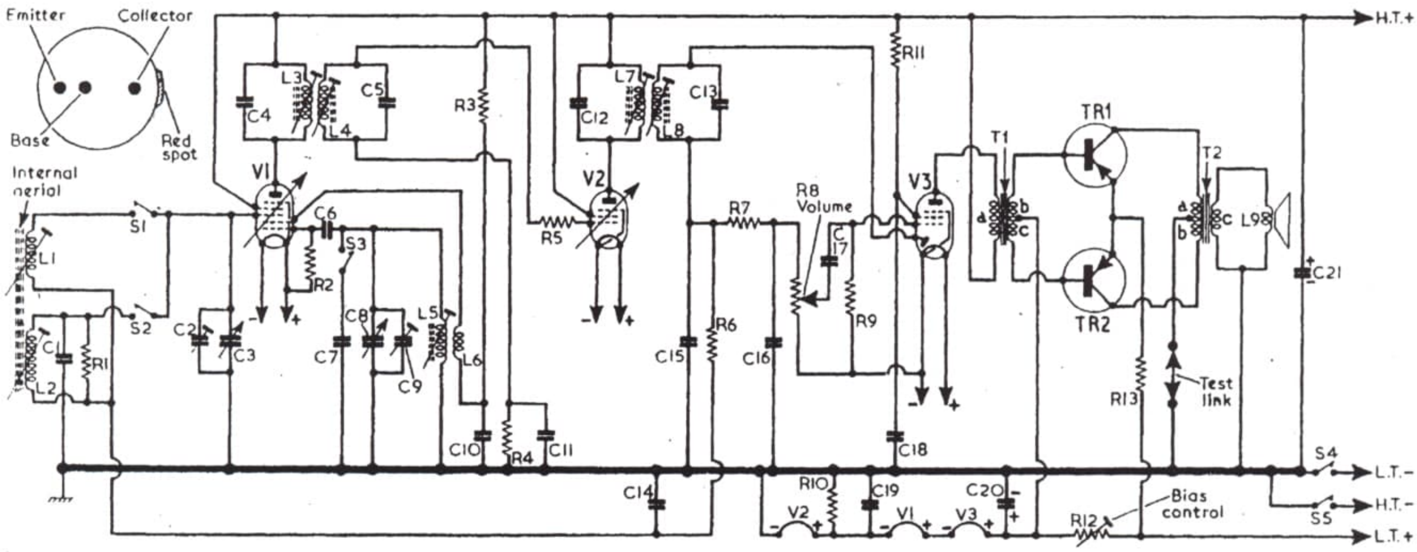
When the 838 came out much was made of the battery life advantage of using transistors. One reviewer commented at the time that the use of transistors reduced the L.T. battery drain from 160 mA to 50 mA 'more than doubling battery life', and I've seen this repeated in a couple of articles. Unfortunately this claim simply isn't true. The 160 mA of the 747 represents the 4x40 mA heaters in parallel at 1.5 V or a total power consumption of:

160 x 1.5 = 240mW.

The 50 mA of the 838 represents 40mA for the vale heaters in series, plus 10mA for the transistor output stage, but all at 4.2 V. Total power consumption is:

50 x 4.2 = 210 mW

So the total L.T. power consumption saving is about 13%. For a given battery type (e.g. zinc carbon), of a given physical size, the total capacity of the battery is given by V(volts) x I(milliAmperes) x Hours, and for the values we are talking of this holds true whether 'V' is large and 'I' is small or vice versa. Given that the 7.5V and 1.5V batteries were of the same physical size, and if they were of the same type you could reasonably expect the 838 battery to last 13% longer than the 747 one, not over 300% as implied by the advertised figures. In fact they are not of the same type, because the E233 battery used in the 838 was a mercury battery which is



Circuit diagram of the Marconiphone P60B. Valve bases are shown above at the left. **R4, C11** *provides bias for V2.* **R12** *may be 12Ω.*

theoretically a more energy efficient battery than the 1.5V Zinc-carbon C cell in the 747. In practice though, there is hardly anything in it, and although the 838 battery might last you 13% longer, being a mercury type it would cost you much more to replace.

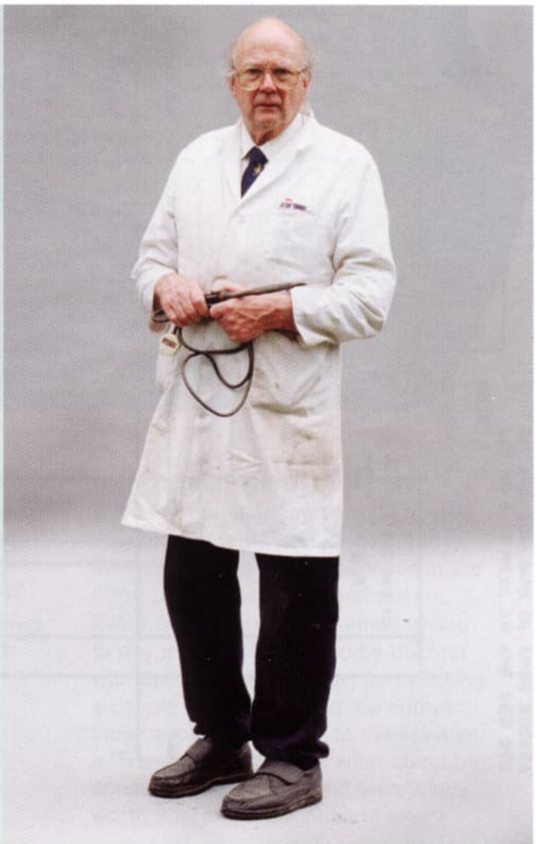
Things are a little rosier on the H.T. side. From the figures quoted on the service sheets, removing the valve output stage reduces the total H.T. consumption from the 4 mA of the 747 to 2.5 mA for the 838. The same type of H.T. battery is fitted in both sets, and it had a capacity of about 140 mA hours. So, very roughly you could expect the 747 to run for 35hrs absolute max. on a battery, and the 838 for 56 hours. That is a worthwhile saving, but even then, I'm not sure that the extra cost of the mercury L.T. battery wouldn't cancel out any overall gain.

Putting all that together; for total H.T. + L.T. consumption for each set you get for the 747, 390 mW. and for the 838, 352.5 mW- a saving of about 10%. Or to put it another way, just over one valve heater!

Final thoughts

The two sets do represent a different design philosophy of miniaturisation. Obviously, due to the lack of sub-miniature valves, Britain could never go as small as the Americans, but even when the first British all transistor sets such as the Invicta Model 30 (Fig. 11) appeared, they tended to stick with wooden cabinets and decent sized speakers. Basically, the Brits were slower to latch onto the appeal of pocket portability, and the willingness of the public to trade sound quality for something truly portable. Trannies need never of course have been tinny if size hadn't been an issue, but it was, and for 20 years or more portable pop culture was synonymous with blaring low fidelity.

Because of sound quality, and in the case of the Emerson, short battery life, neither of these hybrid radios is listened to much in our household. It is nice though sometimes to turn the lights off and just to be able to make out the glowing filament of a valve through the speaker grill of my 'transistor' radio!



Pictures from Golborne, 12th April 2015 by Greg Hewitt

BVWS disposal table stock

Cossor 916 10" television

Ferranti 145 and Ekco AC76

US military oscilloscope

An Arvin 444 Mighty-mite in persimmon

by Stef Niewiadomski

That's pink to you and me, and a bright colour it is! I came across this medium wave only midget radio on eBay and since it was located in the US, I made a cheekily low offer for it, in the hope of re-cooping some of the postage and import duty costs. To my pleasant surprise the offer was accepted, which just goes to show that it's always worth asking, and I received the radio about ten days later.

Figure 1: The Arvin 444 in restored condition: the grey knobs are original. Hopefully you can see the raised lettering of 'Arvin' and the dial calibration markings. There also was a model 444-AH with a carrying handle attached to the top of the cabinet.

Opposite page, top. Figure 2: April 1947 advert for what looks like an ivory Arvin 444, which was branded as the 'Mighty-mite', from the April 1947 issue Radio & Television Retailing. The jpg of this advert was provided by the Radiomuseum.

Opposite page, below. Figure 3: Arvin advert from 1944, encouraging each member of the family to enjoy their own entertainment, and of course each needing their own radio, 'when the war is won'.

Figure 1 shows the radio in restored state, though as you will see later, I didn't have to do too much to the cabinet. The radio is small: at 6-inches wide by 3¾-inches deep by 4¾-inches high, it's an extreme example of the American midget radio.

Brief history of the Arvin name

Arvin was a brand name used by Noblitt-Sparks Industries Inc, based in the US, who started life making air pumps, and then heaters for cars, which were not provided ex-factory in most cases. The company progressed to other car parts, and more significantly from a bygone radio point of view, started to make car radios in 1933, and domestic radios in 1934, in their factory in Columbus, Indiana. They sold these radios under the Arvin trade name, and also produced sets for the likes of Sears, using the name Silvertone. The Arvin name was also used for other domestic electrical items, such as record players, irons and waffle makers.

In 1950, recognising the value of a strong brand name, Noblitt-Sparks changed its name to Arvin Industries Inc, still located in Columbus, and I believe that the company continued to produce radios until the mid-1970s. In 2000, ArvinMeritor Inc, a leading global supplier to the automotive industry, was created by the merger with Meritor Automotive, and the company still exists under the simpler name of Meritor.

My radio was introduced in 1946 and was offered in several cabinet colours, including ivory, blue, yellow, red, walnut, my pink of course, and a stunning chrome finish which I believe attracts a premium in price for collectors. I've also seen one with a brown cabinet – I'm not sure whether this is the walnut coloured model. Of course it's perfectly possible that not all these are original ex-factory finishes. The radio would be relatively easy to re-spray after removing the knobs, and masking off the dial.

Advertising

Figure 2 shows an April 1947 advert for what looks like an ivory Arvin 444, which was branded as the Mighty-mite, from the April 1947 issue of the US trade magazine, Radio & Television Retailing. The retail price of $15.95, coupled with the statement 'You owe it to yourself to get your share of the extra store traffic, the quick sales, big volume and handsome profits the Arvin Mighty-mite brings' implies a very low manufacturing cost, presumably well under $10. In fact the Mighty-mite name had been used for previous Arvin models, originally TRFs and then evolving into superhets. Reference 1 described the restoration of a TRF Mighty-mite.

Adverts for radios in the 1920s and 1930s tend to show the family gathered together around the single, rather expensive, radio in the house. By the 1940s, radio manufacturers were trying to 'separate' families into the father, mother and each child, each with his or her own listening preference, and of course each needing their own radio. In this way, multiple cheaper radios found their way into homes, and hence the total number of radios in use increased dramatically. Figure 3 is another Arvin advert from 1944, encouraging this effect, and preparing families for this investment 'when the war is won'.

Schematic

The schematic of the radio, taken from its Photofact Folder service sheet, is shown in Figure 4. The way the valves are shown results in a rather unclear arrangement: they have been represented in the way a serviceman would see their sockets from the underside of the chassis. This may have been good for the serviceman (which in fairness was where these service sheets were targeted), but doesn't help us get an understanding of the way the radio works, which is supposed to be the function of a schematic. Also it doesn't show the component values, and you have to refer to a table for these values. Interestingly the schematic shows the gains of each of the stages in the radio. I presume this is voltage gain, that is, what you would see on a 'scope if you probed before and after the stage.

The radio contains a mixture of metal and glass envelope octal valves. The frequency changer stage is a Ken-rad 12SA7, producing

an IF at 455kHz; the detector / AF amplifier is a Ken-rad 12SQ7; a Raytheon 50L6GT forms the audio output stage; and finally a Raytheon 35Z5GT is the mains rectifier. These are all 150mA filament valves and were very commonly used in US midget radios.

There being only four valves (including the rectifier), and only one IF transformer, indicated to me that this was a 'short' superhet, which has several possible definitions, depending on exactly which stage is missing. I tend only to use this term for a superhet where the IF amplifier is absent, as is the case with the Arvin 444. The secondary of the single IF transformer drives the signal and AVC detector diodes inside the 12SQ7, without an intermediate amplifier stage.

As you would expect, the power supply section is an AC/DC transformerless design, and since the cabinet is made of thin steel, I was looking forward to seeing how the designers had tackled the problem of making it safe to use. I've restored several Eddystone receivers with AC/DC power supplies combined with metal cabinets, and there the solution is to completely insulate the potentially live chassis from the cabinet by use of Bakelite spacers and washers. With the Arvin, this is not the solution used.

On the schematic, the thick line just above the 35Z5GT symbol is the HT negative line (often referred to as the B- connection in US nomenclature) which is connected to mains neutral via the on/off switch. Note that this is not connected to the metal chassis, which with this radio is also the metal cabinet, and so must be prevented from connecting to either side of the mains. After studying the schematic I was expecting to see a neat and obvious HT negative 'bus bar' spanning the middle of the chassis, with the appropriate components connected to it. In fact it's rather more untidy and well hidden, consisting of several sections of insulated wire that wind their way around the chassis. The HT negative line and the metal chassis are only connected together by the parallel arrangement of R26 (330kΩ) and C9 (0.05µF). These components prevent a possible build-up of charge on the metal cabinet, and earth the cabinet from an RF point of view.

A 1947 incarnation of the radio used B7G-based valves (still with 150mA heaters) in the RE-200M chassis, and I've shown the schematic of this radio in Figure 5. As far as I can see, all the component values are the same as the octal valve version of the radio, but the schematic is much easier to read, and the component values are shown. There was also an RE-201 chassis, where the designers had added in the missing IF amplifier, which was used in the model 544A.

The chassis

Figure 6 shows a rear view of the radio before disassembly for restoration, showing the metal back panel which is only about three-quarters of the height of the cabinet, allowing the heat from the valves to escape. The mains lead, terminated in a US-style two-plug, was very brittle and perished. Therefore it was cut off, and replaced by a new cable with a moulded-on plug.

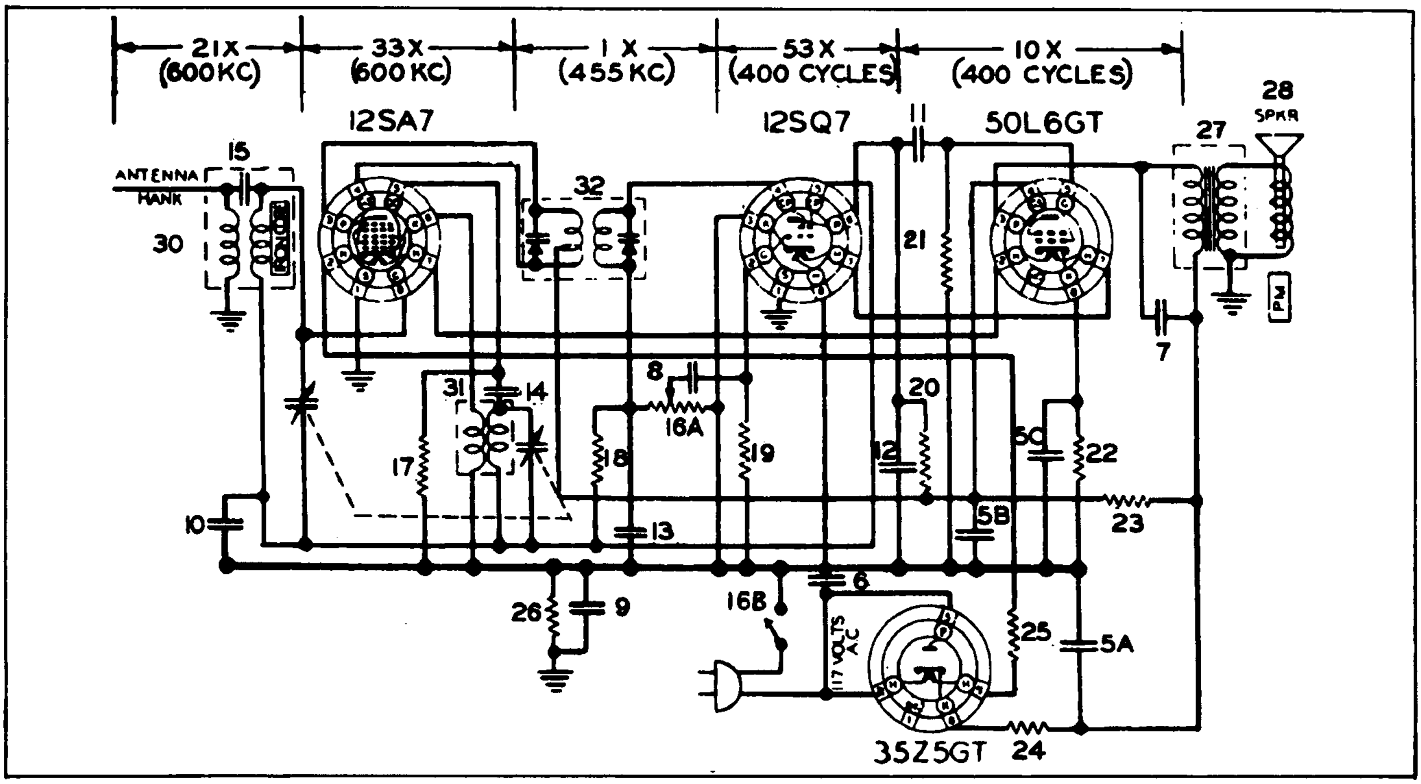
The radio was very easy to take apart. The knob on the volume/on/off control simply pulled off, and the grub screw on the tuning knob unscrewed easily and off it came, along with a felt washer to prevent scratching of the front panel. Two screws were removed from the bottom, and two further screws from the metal back panel.

The chassis slid out easily, complete with its 4-inch diameter speaker, and I was pleased to see a deep covering of dust (see Figure 7) which indicates that the radio hadn't been 'got at', at least for a good while. This version of the chassis was designated the RE-200, and had been used in the slightly earlier model 442.

I removed all the valves to allow better access to the top of the chassis for cleaning, and also to enable me to easily check the continuity of their heaters, all of which measured OK. The chassis had a few small areas of rust, but was generally in very good condition.

Volume control

The volume control was almost completely seized and needed considerable effort with my big pair of pliers to get it to turn at all. I unsoldered its connections and removed it from the chassis so I could get a good look at it. I was of the opinion that it would probably never free up, and so I would need to remove it



The stage gain measured values listed above are approximate values for an average operative stage, rather than an absolute value. It should be borne in mind that it is possible to introduce so many variables into the measurement operation, such as, type of equipment used for measuring, handling and placement of probes, the accuracy of alignment, etc., that an absolute reading is impractical, AVC action is made inoperative and 3 Volt battery bias substituted.

Figure 4: Schematic of the octal valve version of the radio.

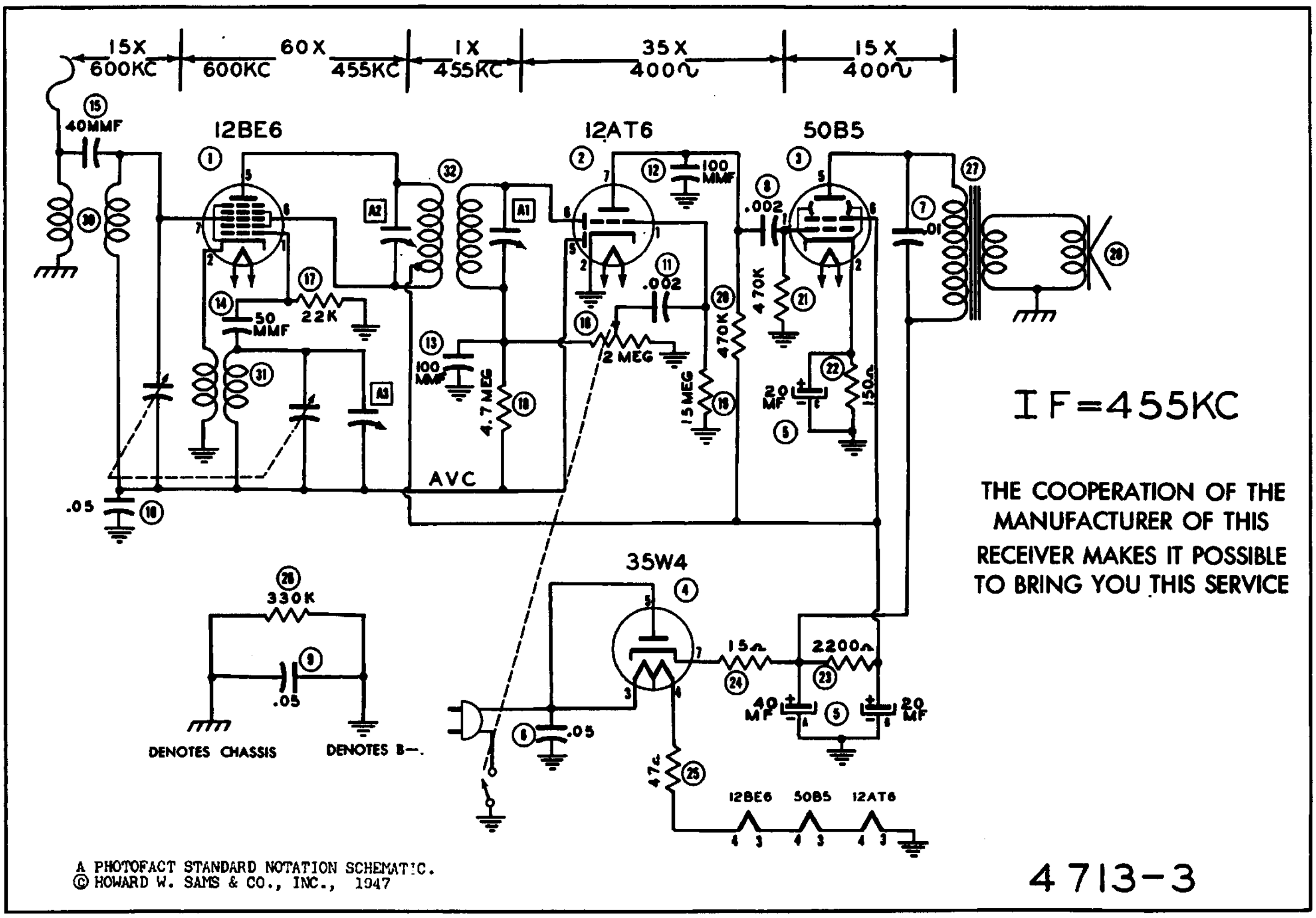


Figure 5: Schematic of the B7G version of the radio (released in 1947), which is much easier to read than the octal version.

Figure 6: Rear view of the radio, showing the three-quarter height of the back panel, and the terminally perished mains lead that was swiftly removed.

Figure 7: Rear top view of the chassis removed from the cabinet, with a deep covering of dust.

Figure 8: The strange, flexible 47Ω resistor, which measured open-circuit, and was replaced by a 'normal' resistor.

anyway and fit a new component. The potentiometer was 2MΩ, so I anticipated a problem with trying to find a replacement. I clamped it in a vice and sprayed its shaft with WD40 and left it to penetrate for half an hour, while I attended to some other tasks on the chassis. The potentiometer then started to turn a little easier, and after a couple more applications of WD40, and more waiting, it was much freer. A few more rotations back and forth, and to my relief I could then turn it easily by hand. The resistance of the volume control measured OK, and the on/off switch was working reliably, so I refitted the component back into the chassis and wired it into circuit.

Most of the resistors checked out to be reasonably close to their nominal values and so were left alone. Only four needed changing, including R24 which should have been 15Ω but measured at 28Ω. This resistor was in series with the HT line from the rectifier and was there to limit the switch on current surge into the first smoothing capacitor. A more critical resistor that needed changing was R25, which should have been 47Ω, but was in fact open circuit. This resistor was a strange loop of flexible wire (see Figure 8) which was open circuit, so the heater chain lacked continuity and the radio definitely would not have worked. I changed it for a 'normal' 47Ω 2W resistor.

I changed all the wax paper capacitors for modern polyester capacitors, but I wanted to preserve the smoothing electrolytic tube, which can be seen just below the speaker in Figure 9, and which was a feature of the original chassis. This tube contains the 40µF (C5A) and 20µF (C5B) HT smoothing capacitors, and also C5C, the low voltage 20µF cathode resistor bypass capacitor for the audio output valve. The centre of the tube was drilled out with successively bigger drills until all the original capacitor material had been removed. I only fitted replacements for C5A and C5B into the

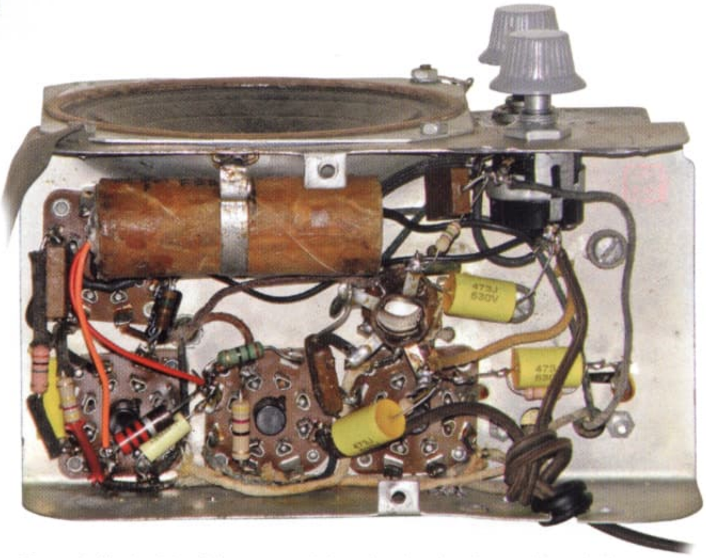


Figure 9: Underside of the restored chassis, showing the cardboard tube of the HT smoothing electrolytic capacitor just below the speaker.

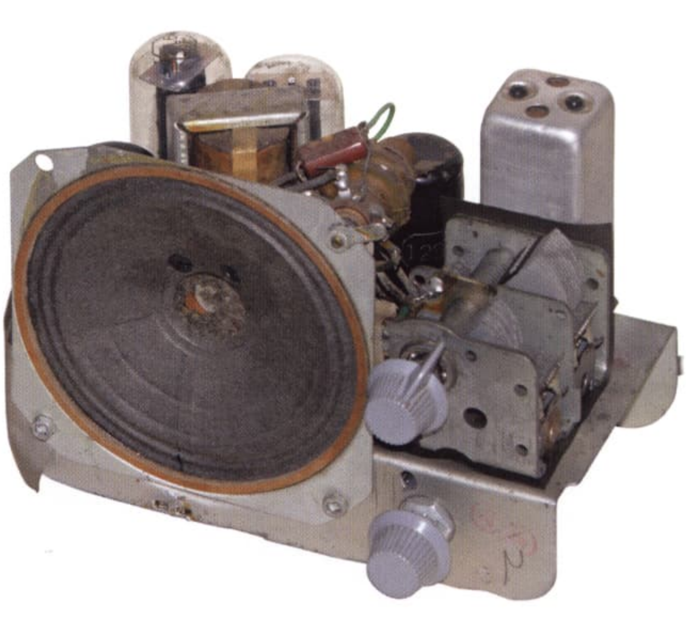


Figure 10: Front view of the chassis before it was re-inserted into the cabinet

Figure 11: The radio's dial, as found. The thin white coat of paint was easy to remove, leaving the gold-coloured dial underneath.

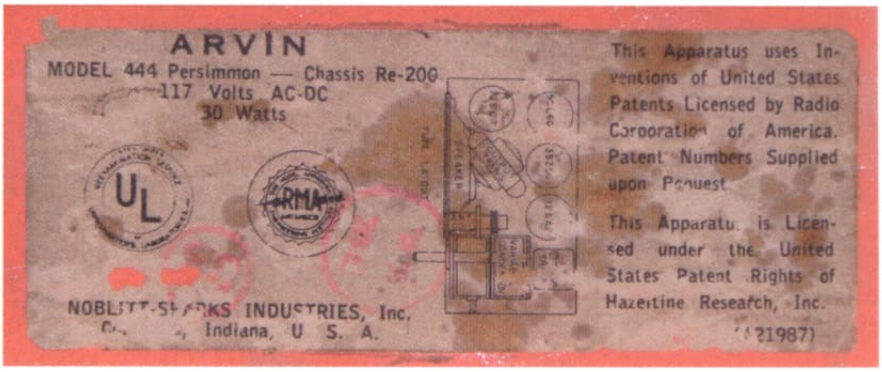


Figure 12: The manufacturer's label on the bottom of the 444's cabinet, typical of what you find on US-manufactured radios. This shows the model and chassis number, and the top-chassis component placement including the valve identities.

original tube, and replaced C5C with a modern component which I positioned out of sight. The cardboard tube had a metal band around its centre and was originally soldered to the chassis, and I re-soldered it back into its original position.

Switch on and testing

A careful check around the chassis confirmed that all the wiring looked correct, with good soldered joints, and the components (the original ones and the ones I had replaced) were in the right positions. I fitted a new mains cable, re-fitted the valves, fitted the knobs, plugged the radio into an auto-transformer supplying about 115V and switched it on. I carefully checked that the HT- line was connected to the neutral side of the supply, rather than the live side. There is no dial lamp to verify that the radio was switched on, but I could see the valves start to glow, and could hear a faint hum from the speaker. This was with a very short length of wire attached to the aerial connection, so in hindsight I'm not sure what I was expecting to hear.

I clipped on a short aerial and could now hear 5Live loud and clear, but absolutely nothing else as I tuned around the medium wave. So I added more wire to the aerial, to make a total length of about 30 feet, and could now hear more stations. I loosely injected a modulated signal at 1400kHz and tweaked the cores on the IF transformer, and the trimmer on the oscillator section of the tuning capacitor, for maximum audio output. Switching back to the aerial, things were now a lot livelier across the band, although I must admit that the absence of any slow motion drive made it tricky to get the best results from weaker stations. Figure 10 shows a front view of the chassis before it was re-inserted into the cabinet.

I was happy now that the radio was as good as it could be, so I re-installed the chassis into the cabinet, and switched it on again for a soak test for a couple of hours during which it continued to work very well.

Cabinet and dial

The pink cabinet was in reasonably good condition, with just a few rust spots which I wasn't going to try to remove as this would have spoiled its 'honest' condition. However the dial definitely needed some attention, see Figure 11 for its 'as found' state. The dial calibration numbers were formed by raised areas when the cabinet was punched out from the flat. I presume it was Noblitt-Sparks' automotive connection that gave access to the heavy presses needed to form the metal cabinet.

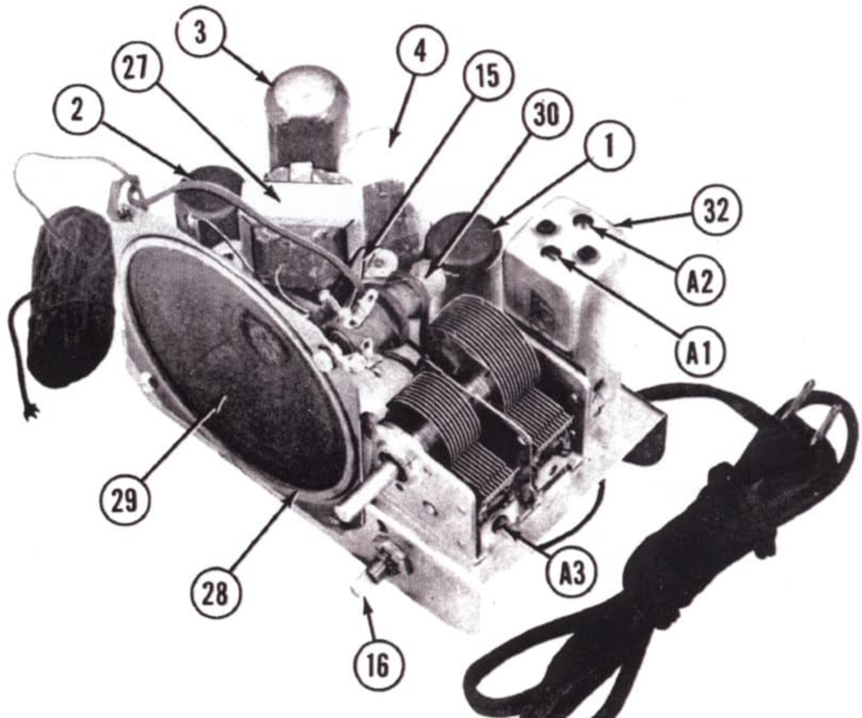


Figure 13: The Photofact Folder illustration of the 444's top of chassis.

At first I thought that the gold paint was peeling off, revealing a white primer underneath, and would need a re-spray to get to an acceptable state. Then I looked more closely, and I could see that a previous owner had painted over the original finish with white, and it was this layer that was peeling off. This made my life considerably easier, as I could simply scrape off the remaining white paint with my finger nail, revealing the original finish.

The manufacturer's label on the bottom of the cabinet is shown in Figure 12, and is typical of what you find on US-manufactured radios. It's a very useful label, showing the model and chassis number, and the top-chassis component placement including the valve identities.

Sources of data for US radios

There was a series of service sheets called Photofact Folder, published by Howard W Sams & Co, in the US, similar to the Trader sheets that were published in the UK. Scanned versions of these are available on-line and many originals can be found on eBay. It's worth buying one or two of the originals and seeing their excellent production quality, usually including a couple of photos of the chassis being described. Figure 13 shows the Photofact Folder illustration of the top of the chassis of my Arvin 444, showing the location and designations of the major components.

In the US there was also a series of annually-published booklets called 'Manual of 1940 Most Often Needed Radio Diagrams', and so on for each year, with a gap for some of the war years. These contained a single-page condensed version of the schematic for typically 200 radios each year, and sometimes included the chassis layout and dial cord arrangement. Original versions of these can be bought on eBay.com, and scanned on-line versions can be found on various websites.

Summary

This very attractive American midget short superhet was manufactured in a cabinet made from thin sheet steel, and finished in pink. The manufacturer advertised the radio as being 'unbreakable' which was probably true, though it might have suffered a dent, and possibly broken valves, if dropped from height. Certainly it wouldn't have suffered as much damage as a radio with a Bakelite or plastic cabinet would have.

The radio illustrates very well how you can have a transformerless AC/DC power supply without having a live chassis, by restricting the potentially live section in the circuit to a node that is insulated from the chassis, which in this radio is connected to the metal cabinet.

The Switzerland-based Radiomuseum at: http://www.radiomuseum.org/ contains descriptions, photos and schematics of uncountable numbers radios from all over the world, including the Arvin radios mentioned here. I'd like to thank the museum for giving me access to the jpg used in Figure 2.

Reference

Reference 1: 'Repairing a Mighty-Mite' by Peter Roberts, published in The Radiophile issue number 117, Autumn 2009. The radio uses a 25B5GT triode-pentode as RF amplifier and detector; a 50L6GT beam tetrode as audio output; and a 35Z4GT as half-wave rectifier.

Photographs from the table top sale at The British Vintage Wireless and Television Museum, West Dulwich

photographed by Mike Barker

Stallholders and a few early visitors

John Sully manning the entrance

Making a coil winder by Frank Cuffe

In 2007 I built my first coil winder (fig.1) which consisted of four sections that I called the Supply Reel, Take-up, Control Unit and Transverse. I purchased a hand cranked Take-up online, then built the Supply Reel, Control Unit and Transverse to go with it.

A coil winder is something I just couldn't do without, as I seem to end up with a disproportionate amount of sets with open circuit Transformers and coils. With my old winder I have wound all sorts of coils, it served me well but had started to show signs of wear, particularly the supply reel. I had originally decided just to rebuild the Supply Reel but once I had that built it became obvious that the rest of it could do with being updated too.

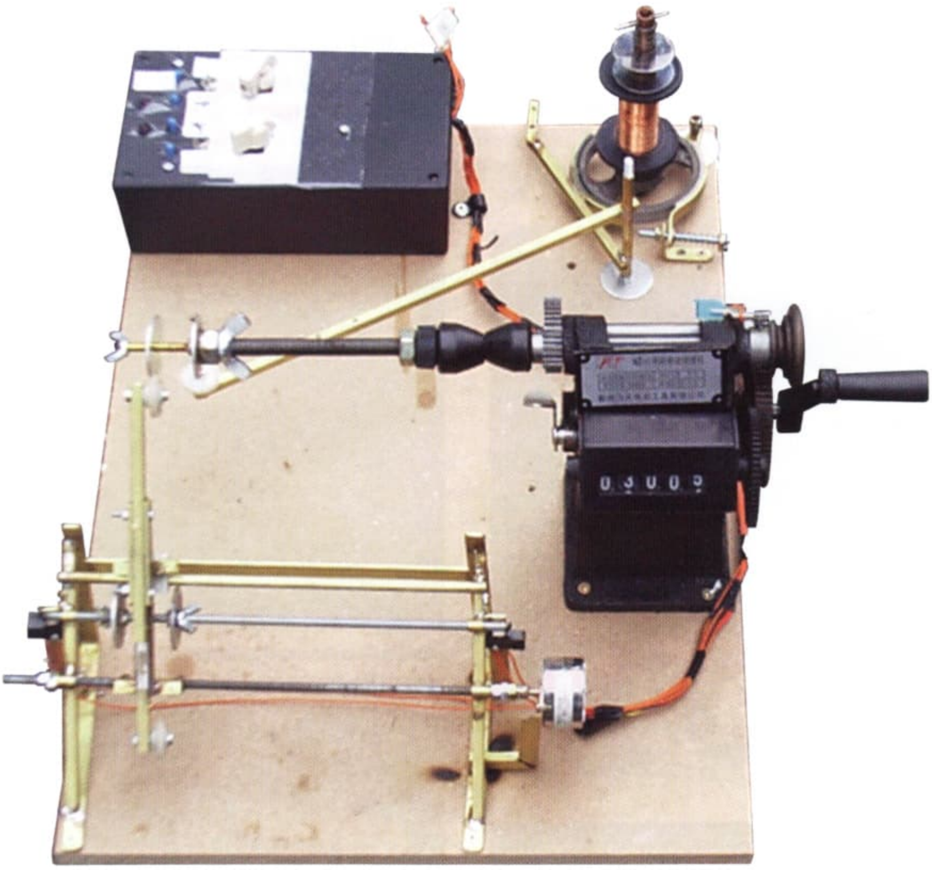


Fig 1. The old coil winder

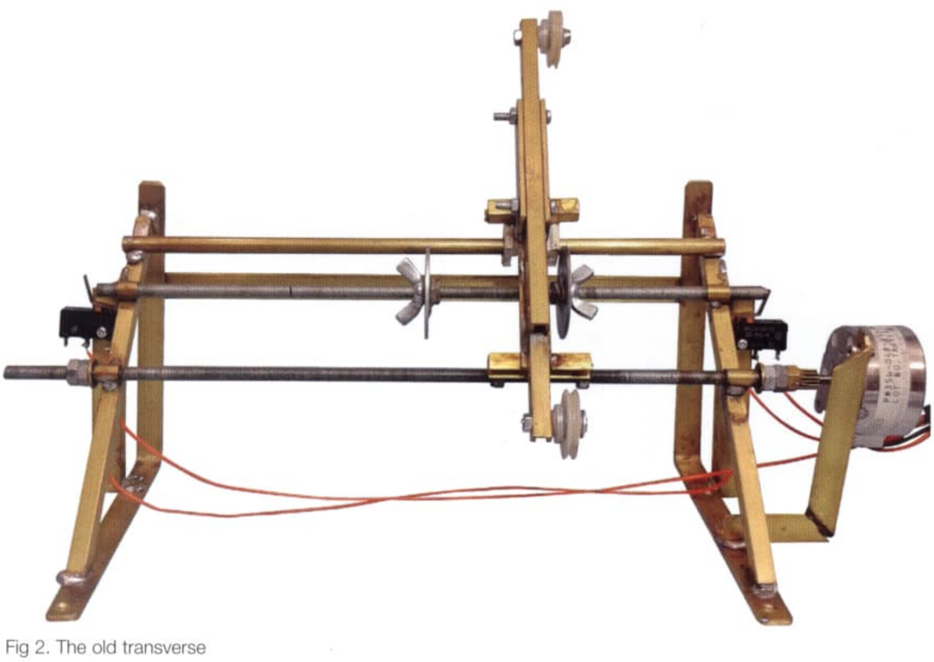


Fig 2. The old transverse

I like using the hand cranked winder as a lot can be told from the pressure required to drive the winding handle. If the wire breaks or is not coming off the supply spool as freely as it should, if there is not enough back tension or even if the wire goes outside a former cheek, can all be felt in the winding handle. The new build started out to replicate this but after building the hand cranked Take-up it became clear that an automatic winder could be made without too much effort by building a motorised Take-up. I built the Take-up's so they could be easily exchanged so in the end I had a winder that could be either hand cranked or fully automatic.

My old winder was put together quickly and was more a proof of concept than a finished one, I had always hoped to rebuild it but until now just hadn't got around to it. This time I intended to take my time, building it one section at a time and build it as good as possible with the limited tools that I have. Apart from the usual hand tools found in most workshops the only other tools used were; a tap and die set, a propane torch for silver soldering, a Dremel, a hand drill and a pillar drill. A router and a table saw were also used but were not essential. The materials were either purchased from a local hardware store or online. To keep the build simple the main structures of the winder were made from MDF which were glued and/or screwed together.

The old winder had no bearings apart from one in the supply reel, all the rest of the moving parts just slid on each other and there was quite a bit of play between them. This time by employing bearings wherever possible I hoped to reduce or eliminate play as well as keep everything running smoothly.

The biggest difference between the new and old winders is the way the Transverse is controlled, the old controller was a simple design but was also very effective. Setting it up involved a little trial and error particularly if using a wire guage that hadn't been used before. By using a PIC I intended to make setting the transverse up much easier and more accurate. As it may be of interest I will first describe the old Transverse and its Controller.

The Old Transverse and Controller

The main structure of the old transverse (fig. 2) was made from brass angle and strip. To move the carriage I used a M5 threaded rod as the lead screw with a stepper motor directly coupled to it. The lead nut was

Fig 3. The supply reel - complete

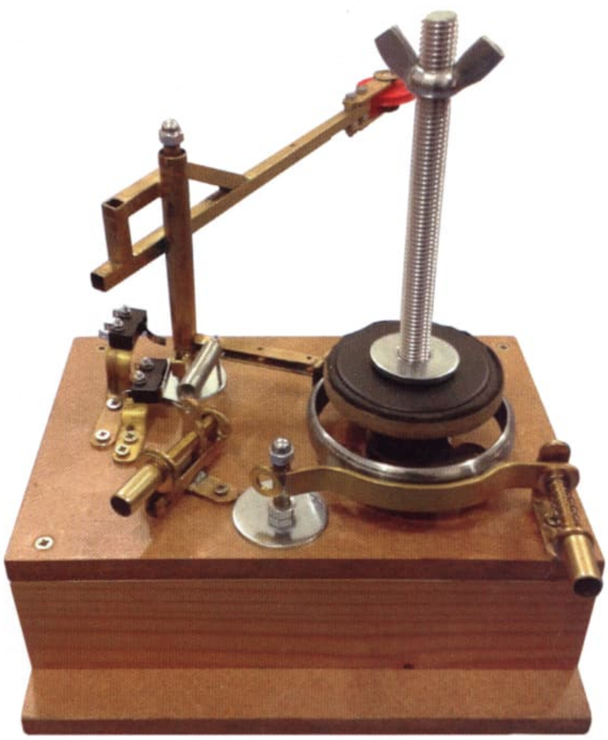


Fig 4. The supply reel - complete

Fig 5. The supply reel - parts spindle and bearings

Fig 6. The supply reel - parts base

Fig 7. The supply reel - parts jockey pulley

two M5 nuts spaced about 25 mm apart which were soldered directly to the lower end of the brass carriage. A plastic slide connected to the upper end of the carriage slid along a brass tube. The stepper motor was out of a fax machine and had 20 steps per revolution. A 'Johnson Electric Unipolar Stepper Drive' that was purchased from RS (RS number 443-0102) was used to drive the Stepper Motor. The Stepper Drive has its own internal oscillator that could be varied by a Pot, which set the speed that the motor runs at, its frequency was set as high as possible without the Motor losing torque.

A magnet mounted on the shaft of the Take-up activated a nearby reed switch once per revolution. The reed switch trigged a NE555 timer that was in monostable mode. The output of the monostable was connected to the 'clock disable' pin of the Stepper Motor Driver. When the output of the monostable is positive the motor can move. Two pot's 100k "COARSE" 10k "FINE" were used to vary the pulse length. By controlling the pulse length the number of steps moved per revolution of the Take-up spindle can be varied to suit the wire diameter. The lead screw had a pitch of 0.8 mm, with the half step function enabled on the controller there are 40 half steps per revolution that gives a carriage movement of .02 mm per half step.

To control the direction of travel another M5 threaded rod was used with a micro switch positioned close to each end of it. This rod carries two M5 nuts one each side of the carriage with large washers soldered onto them. The washers could be screwed along the length of the rod to line up with the respective ends of the coil and when in the correct position were locked in place with wing nuts. When the carriage hits a washer it will push the end of the rod against a micro switch and activate it. The micro switches were connected to another NE555 in bistable mode, one micro switch sets the bistable the other resets it, the output of the bistable is connected to the 'clock wise/counter clock wise' pin of the Stepper Motor Driver which controls the direction of the stepper motor and hence the carriage.

The New Build:

The Supply Reel (fig. 3 and 4)

If small diameter wire is to be wound it is important to have a way of delivering the wire freely without breaking it while still keeping enough tension on it to be able to wind a good quality coil. Most Supply Reels that I have seen are mounted horizontally, but I like to keep them vertical as this minimises the effect of any imbalance in the reel itself or spool of wire. The downside of mounting it vertical is that with a full spool, if the wire is not kept tightly wound it can slip down and off the spool.

The spindle (fig. 5) is made from 10 mm rod with a M10 thread cut into most of it. Mounted at the lower end of the threaded portion of the rod is a brake wheel. The brake

Fig 8. Supply reel - parts jockey arm and brakes

Fig 9. Supply reel - parts tension adjusters Left jockey wheel Right back tension

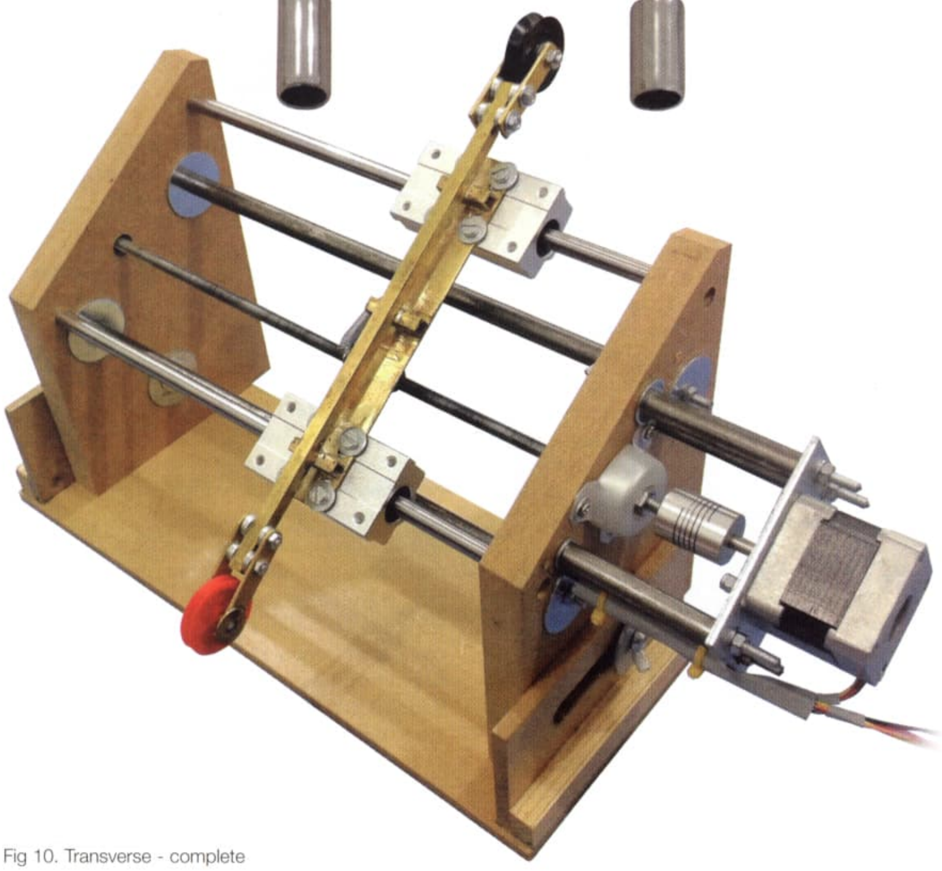


Fig 10. Transverse - complete

wheel was made from a balance wheel from an old 'Koltec' battery fence. The striker on the balance wheel was sawn off and sanded flat to make a smooth surface for the brake shoes. As it happened the hole in the centre of the wheel was the correct size to fit onto the threaded rod. Over the brake wheel is a table made from 6 mm MDF covered in rubber foam that the spool of wire sits on. To hold the spindle vertical the unthreaded part of the spindle fits into two bearings mounted on the base (fig. 6). A thrust bearing fits between the brake wheel and the base to support the spindle, a dust cover made from a milk bottle cap is fitted over the bearing. The spool of wire is placed onto the threaded spindle and held firmly in place by tightening a wing nut on the spindle.

When winding a round section coil such as a speaker field coil the wire is drawn at a relatively even speed, however this is not the case when winding a square section coil as in most transformers. As the wire goes round each face of the coil former the distance from the feed pulley to the point where the wire contacts the former is constantly changing this results in the wire being drawn at a continuously varying speed. The spool of wire has a relatively large mass that wants to revolve at a fairly constant speed and cannot react quick enough to the varying speed that the wire is being drawn at. This would result in the wire going from been slack to being over tensioned and at best the outcome would be a poorly wound coil as the wire tends to wander during the slack periods or at worse the wire would break from the over tension. In order to stop this from happening something is needed to marry the varying speed to the constant speed, in this winder I have used a jockey pulley.

For the jockey pulley (fig. 7) I used a 40 mm plastic pulley with a 4 mm bore. It is mounted on a 4 mm shaft with bearings at each end. Spacers made from brass tube keep the bearings clear of the wheel. Both ends of the shaft were turned down with a hammer to hold everything together. The jockey wheel is mounted with brass bars, one each side of the wheel with 7 mm holes drilled into them to accept the bearings, the outside of the hole has a brass washer soldered to it to keep the bearing in place, the hole in the washers had to be widened slightly to stop the shaft from fouling against them. These bars with the jockey wheel between them are then mounted onto the jockey arm with M3 screws and nuts, washers between the bars and the jockey arm keeps the bars aligned correctly.

To allow the jockey pulley to be positioned to suit the coil been wound, the jockey arm is made from two lengths of different width box section brass tube, one slides snugly inside the other to make up a variable length arm. When the arm has been adjusted to the required length, it can be locked at that length by placing a bolt through the holes that were made along the length of the tubes. The jockey arm and the main brake (fig. 8) are connected to a brass tube. Bearings were fitted to each end of the tube, using a pipe cutter two depressions were formed around the circumference of the tube close

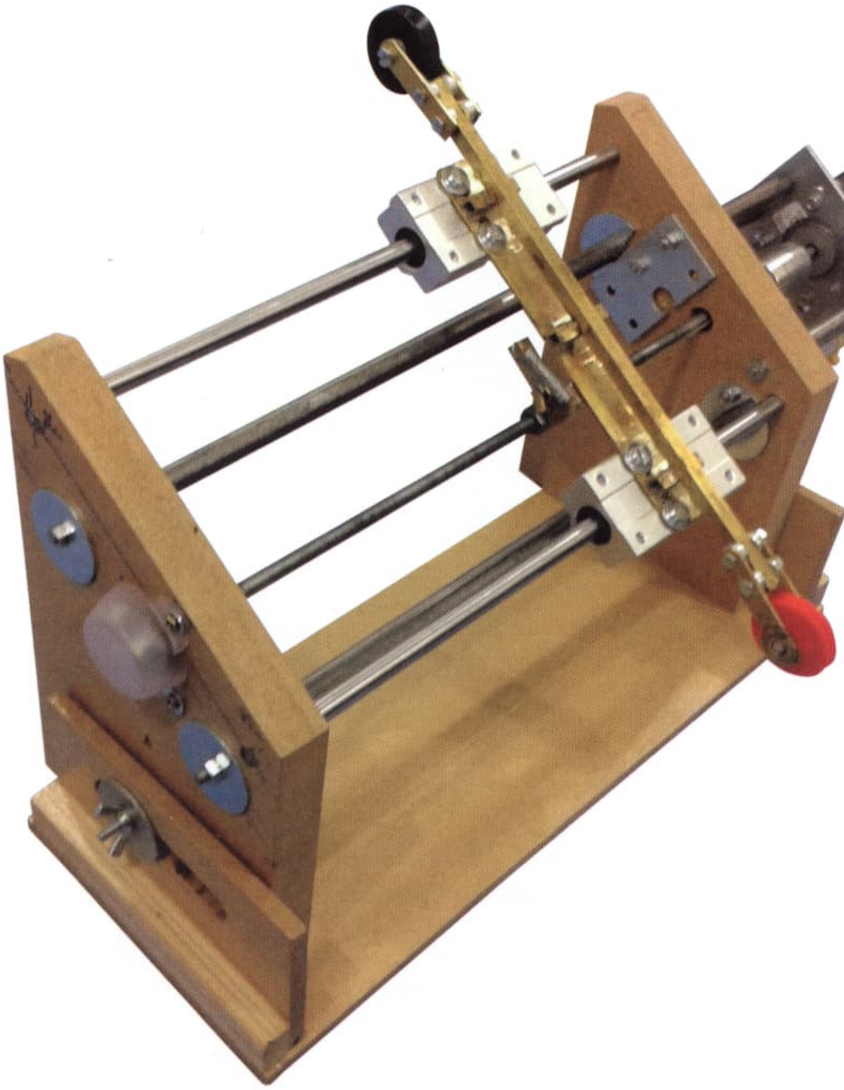


Fig 11. Transverse - complete

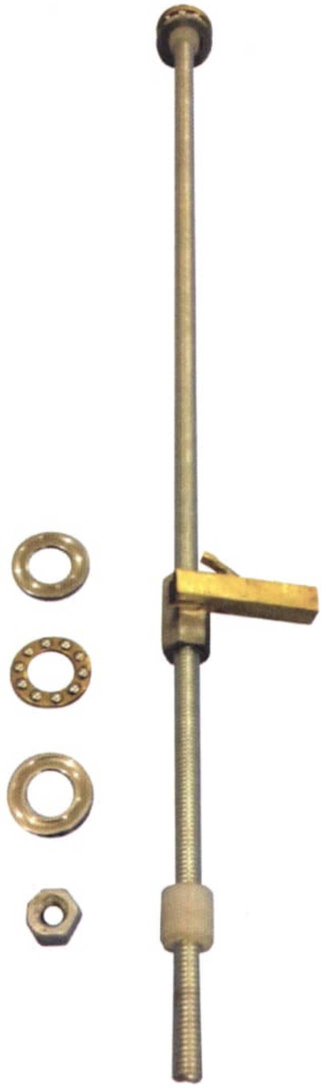


Fig 12. transverse - parts lead nut and screw with spacers fitted also thrust bearings

Fig 13. Transverse - lead screw thrust bearing

Fig 14. Transverse - parts lead nut

Fig 15. Transverse - carriage to lead screw coupling

to each end that prevents the bearings from sliding all the way into the tube. To form a pivot the tube with the bearings inserted in it slides onto a 5mm rod that is mounted on the base of the Supply Reel. Spacers made from 6 mm brass tube are fitted onto the rod to stop the bearings from fouling against the base or top nut. A small portion at the top of the rod has a M5 thread cut in it to accept a nut to hold everything in place.

The jockey pulley adjustment (fig.9) was made from pieces of brass that forms a simple nut and screw adjustment that is mounted on the base. This adjustment varies the tension a spring exerts on the jockey pulley.

The main brake is operated by the jockey pulley arm and works effectively regardless of the tension that the jockey pulley is set at. It operates like a wedge in that when the shoe is offered up to the brake wheel, the brake wheel grabs it and pulls the brake shoe tighter against itself, its shoe is made from brass strip and is rubber lined.

The back tension break shoe is made from brass strip that is felt lined. A pivot is formed at one end of the shoe by a 6 mm brass tube which fits over a 5 mm rod that is mounted on the base. At the other end a screw which passes through a spring and also a hole in the shoe, is screwed into a nut which is attached to the base by a bracket. This screw is used to adjust the pressure that the spring exerts on the back tension brake.

Two switches that are operated by a cam on the jockey pulley pivot, provide feedback to the controller. The brake switch is activated when the main brake is on and the over tension switch is activated if the jockey pulley extends beyond its normal working range.

The Transverse (fig. 10 and 11)
When building the Tranverse it was important that the two linear bearing guides and lead screw are parallel to each other. This is particularly so for the linear bearing guides, for if there is any slight misalignment between the guides the linear bearings will bind, therefore particular care was needed when making the end supports so that they line up correctly with each other. The two

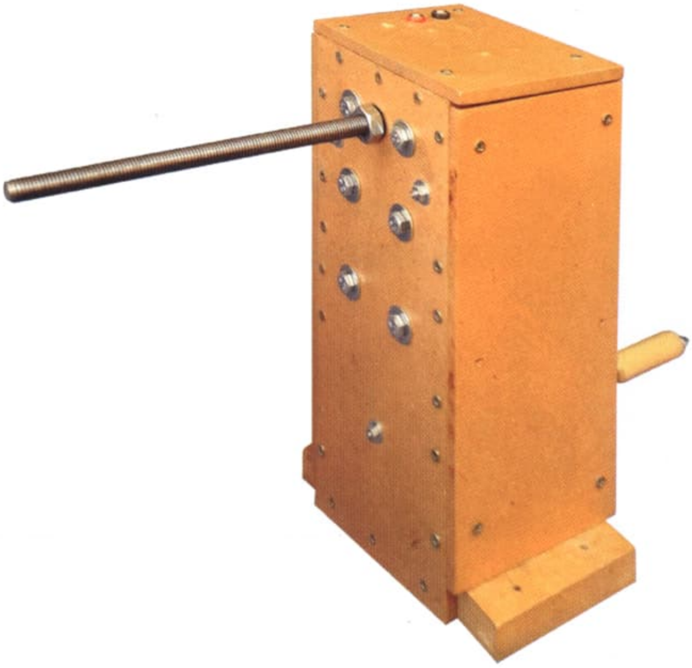


Fig 16. Hand cranked take-up - complete

Fig 18. Hand cranked take-up - complete

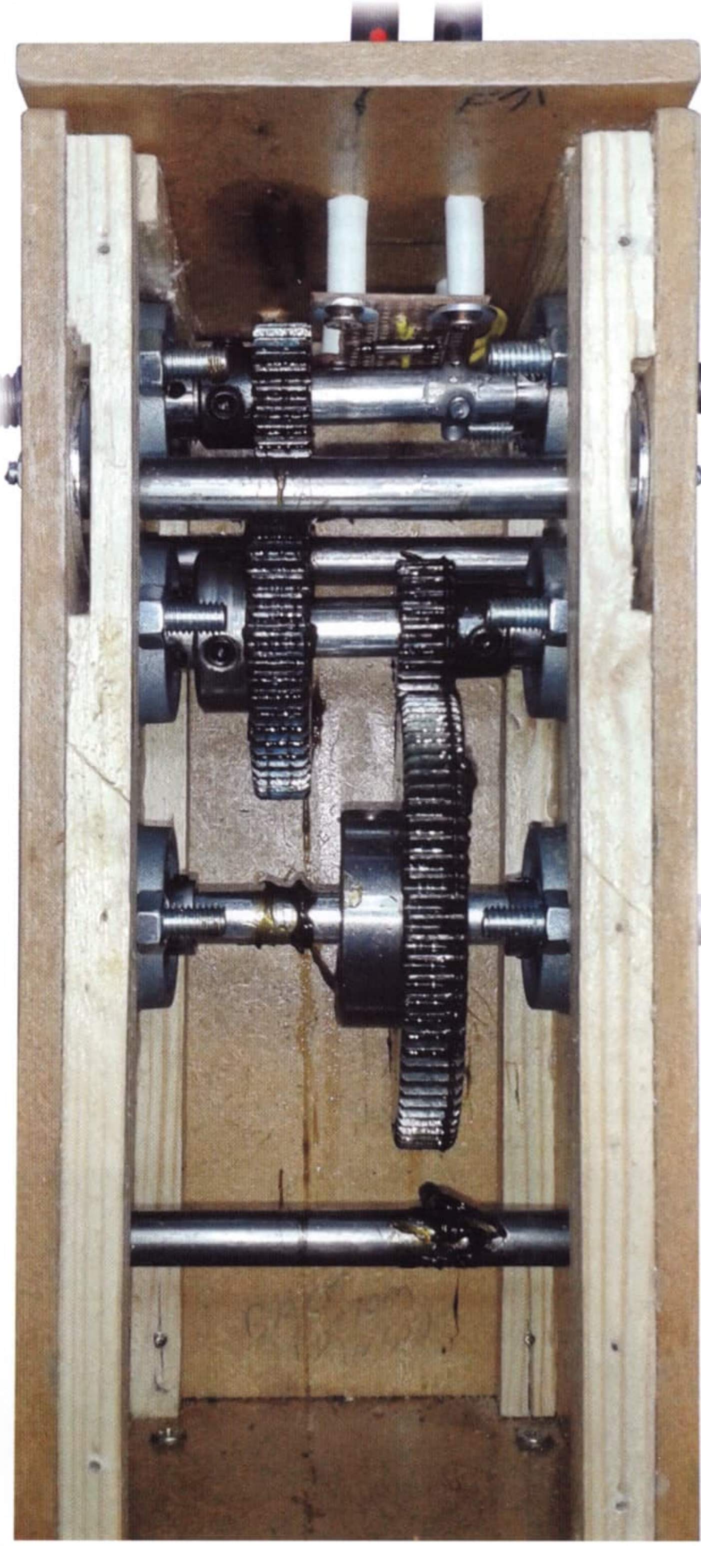


Fig 18. Hand cranked take-up - inside view

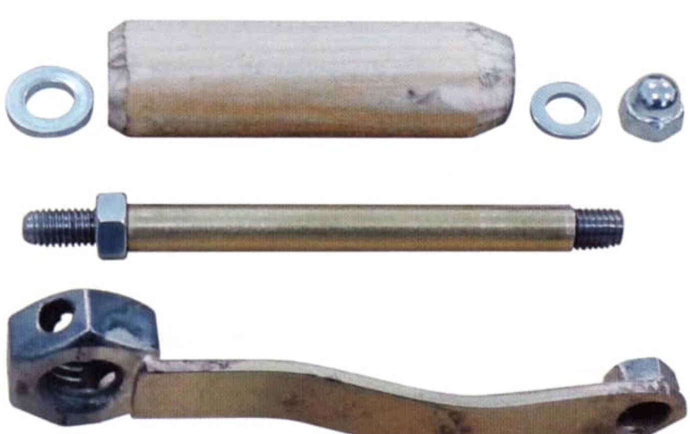


Fig 19. Hand cranked take-up - parts for handle

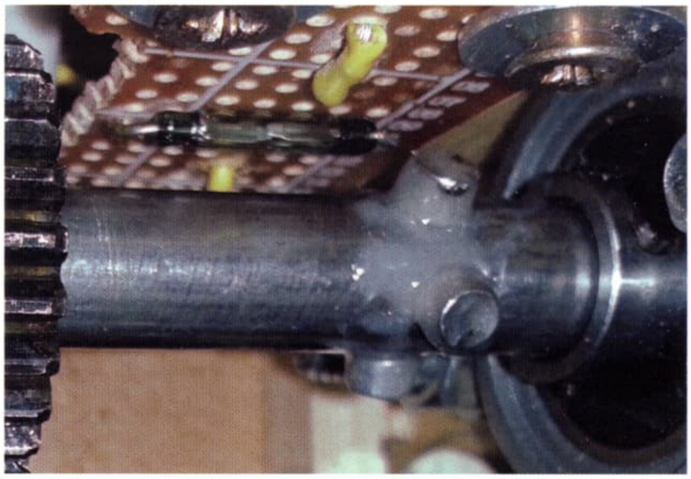


Fig 20. Hand cranked take-up - close up of magnets and reed switch

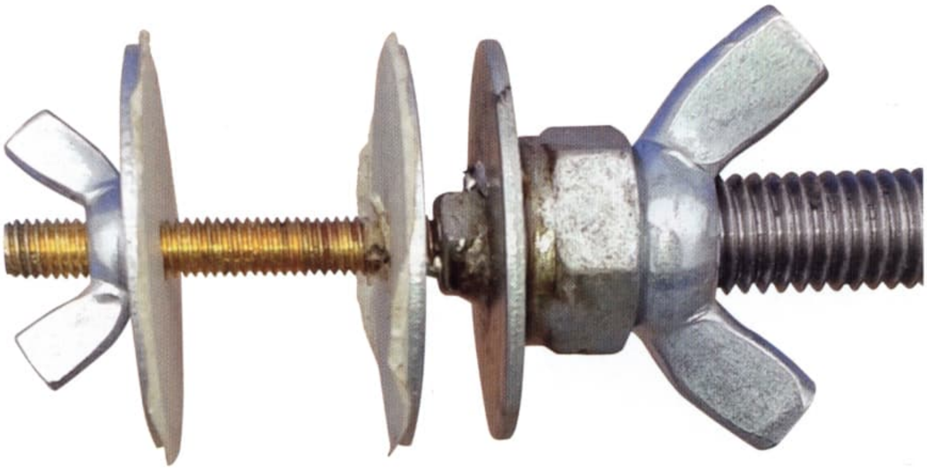


Fig 21. Hand cranked take-up - small coil adaptor

Fig 22. Take-up - complete

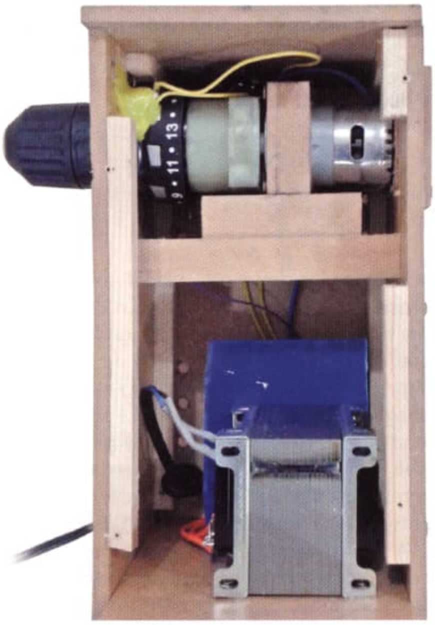


Fig 23. Take-up - inside view

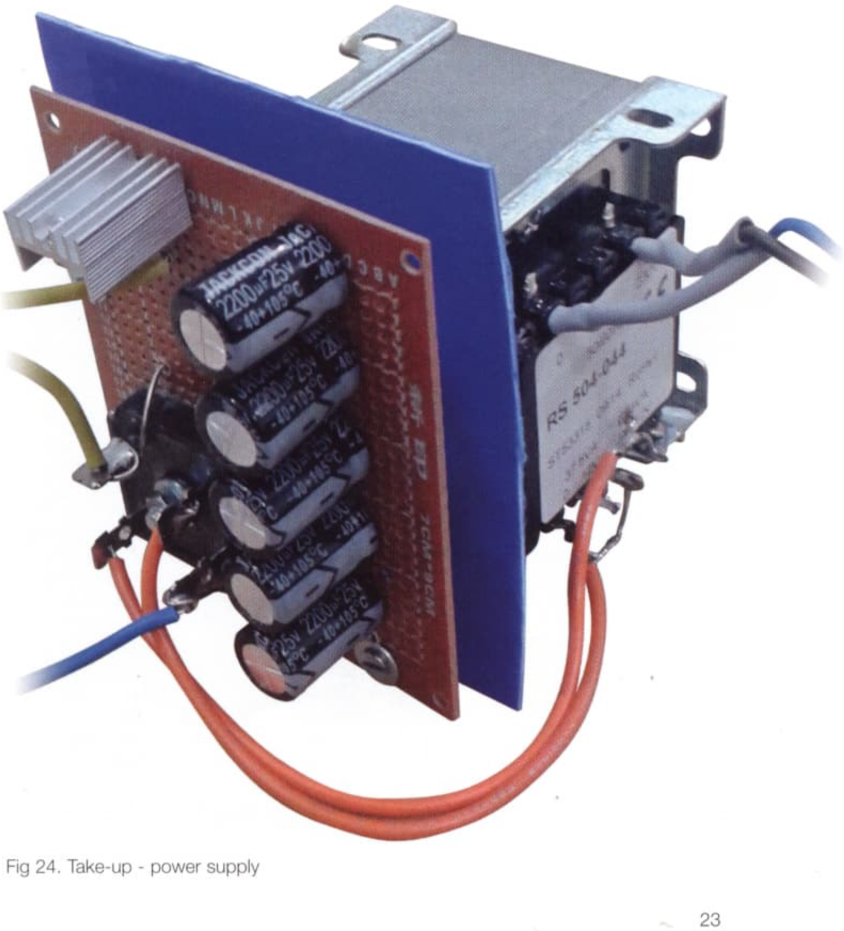


Fig 24. Take-up - power supply

end supports are made from 18 mm MDF. To ensure that the two end supports were mirror images of each other, two pieces of MDF were placed one on top of the other and held together with wood screws while the holes were drilled and the panels cut to size. The screws were placed close to the edges where they were on waste material that would be removed later.

One side was then marked out and all the holes were drilled from this side through the two ends with a pillar drill, 8 mm holes for the linear bearing shafts and 5 mm holes for the brace rods. To make the housing for the lead screw bearings, which had an outside diameter of 15 mm and a width of 4 mm, first a pilot hole of 2 mm was drilled. Then from each end using a forstner bit a 15 mm hole was made to a depth of 5 mm, the centre was then enlarged to 12 mm to make clearance for the lead screw and its spacers. The ends were then cut to their final size on a table saw, the final cuts removed the waste material that the wood screws were in. The ends were then given a coat of varnish as was the other parts of the winder that was made from wood.

The lead screw bearings were push fitted into their housings by carefully tapping them in with a hammer. The linear bearing guides were also push fitted into their holes, nothing more was required to hold them in place. Three lengths of 10 mm steel tube keeps the ends spaced apart while three M5 brace rods and nuts clamps the ends together, this makes for a good solid structure.

A 6 mm MDF panel with a horizontal slot cut in it, is placed on the outside of each end and is fastened to the base board. The lower brace rod of the transverse passes through the slots and a wing nut on each end allows the transverse to be easily clamped to the panels. This arrangement allows adjustment of the distance between the transverse and the Take-up so different sized coil formers can be accommodated.

Originally I had the carriage mounted on just one linear bearing on each guide but this wasn't very successful as the carriage tended to pivot around the coupling to the lead screw. Using two bearings on each guide removed all unwanted movement. A length of square section brass tube runs the length of the carriage, the guide pulleys are mounted at each end of it. Initially I made all the pulleys for the Transverse in the same way as the jockey pulley but they wobbled slightly which didn't matter for a jockey pulley or the lower pulley on the carriage, but any wobble no matter how small is not something that is desirable in the feed pulley. To eliminate wobble the feed pulley was changed to a 29 mm nylon vee pulley that had an internal bearing.

The lead screw (fig. 12) is a M6 threaded rod. It sits in bearings at each end. The bearings have an internal diameter of 10 mm. In order to keep the lead screw centred in the bearings, spacers were required. I first tried grinding down M6 nuts to a diameter of 10 mm, this worked to a fashion but as there was play between the nut and screw threads it was difficult to get and keep the screw centred in them. In the

Fig 25. Control unit

end I used nylon spacers with an internal diameter of 5 mm and that were 12 mm long. The spacers were screwed onto the lead screw and cut their own thread as they went, this made for a good tight and centred fit. The spacers had an outside diameter of 10 mm but I found they needed to be sanded slightly to fit snugly inside the bearings. A thrust bearing(fig. 13) at each end of the lead screw that are held in place with lock nuts prevents any lateral movement. Dust covers were made for the bearings from small aerosol can caps.

To couple the carriage to the lead screw, there is an arm on one side of the carriage that points towards the lead screw. The lead nut (fig. 14) is a 20 mm long M6 nut, it has a short arm made from square section tube soldered to it at 90 degrees to the lead screw, this arm has a small piece of brass soldered to it, that forms a Vee with the tube. The arm on the carriage fits into this Vee and is held in place by a spring (fig. 15). The action of the spring also keeps one side of the lead nut pressed against the lead screw. This arrangement works very well with no undue friction between the lead screw and nut, and with no perceivable play between the lead screw and the carriage.

A 5 mm internal diameter aluminium coupling connects the lead screw to the stepper motor. One end of the coupling was tapped with a M6 thread, so the coupling would screw onto the end of the lead screw. The stepper motor has 100 full steps per revolution, each full step will therefore move the carriage laterally by 10 um. In order to move the carriage at a reasonable pace each step needs to be taken in 2 ms.
It was found that for sufficient torque at this speed a supply voltage of 18V was needed. 18V was far too high as a holding voltage for the stepper motor as it would cause it to soon overheat. Accordingly 4.5V is used as the holding voltage and the controller increases this to 18V immediately before a step is taken, this arrangement keeps the motor nice and cool while at the same time providing good torque.

As an effort to give the motor extra starting torque, the time taken for the first and second steps in a sequence is increased to 4 ms and 3 ms respectively, after fully building the Transverse it became clear that this wasn't really necessary as the motor had ample torque.
There isn't any need for position switches on the Transverse as the controller counts the steps the motor takes to keep track of the carriage position.

Unlike the AVO winders where the carriage moves linearly with the Take-up spindle, the carriage on this winder moves in one burst just after a pulse is received from the Take-up. Using one pulse per revolution works well except at the ends of the coil, where if the carriage is very close to an end stop when a pulse is received the carriage then moves away almost a wire width from the end before it can be filled. As an effort to improve the filling-in of the ends, four magnets are used instead of one which gives better indexing of the coil, the carriage will therefore move approximately one quarter of a wire diameter for every pulse that is received from the Take-up.

The Hand Cranked Take-up (fig. 16 and 17)
The hand cranked Take-up on the old winder was purchased from China. It worked well but had a couple of bad points. It had no bearings, just ran steel on steel that needed constant oiling to keep it running smoothly, the gears needed

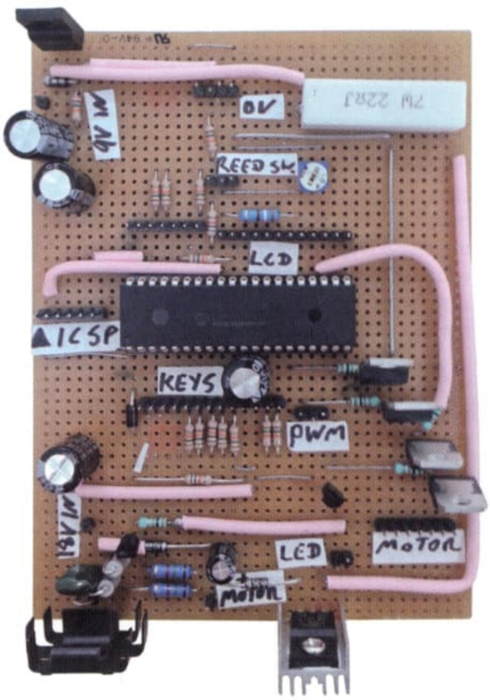


Fig 26. Control board

Fig 27.

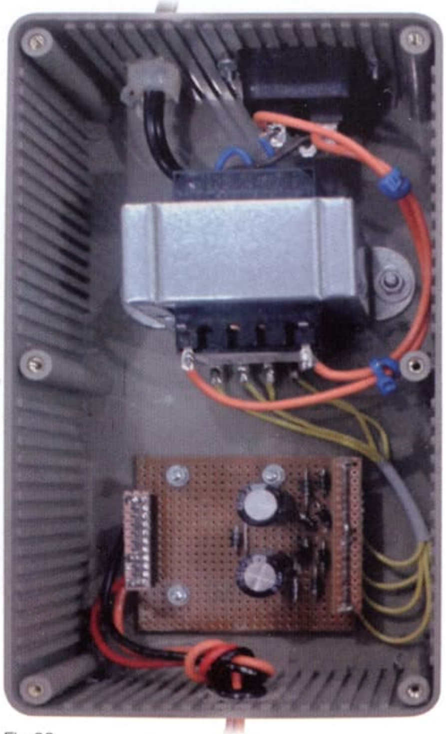
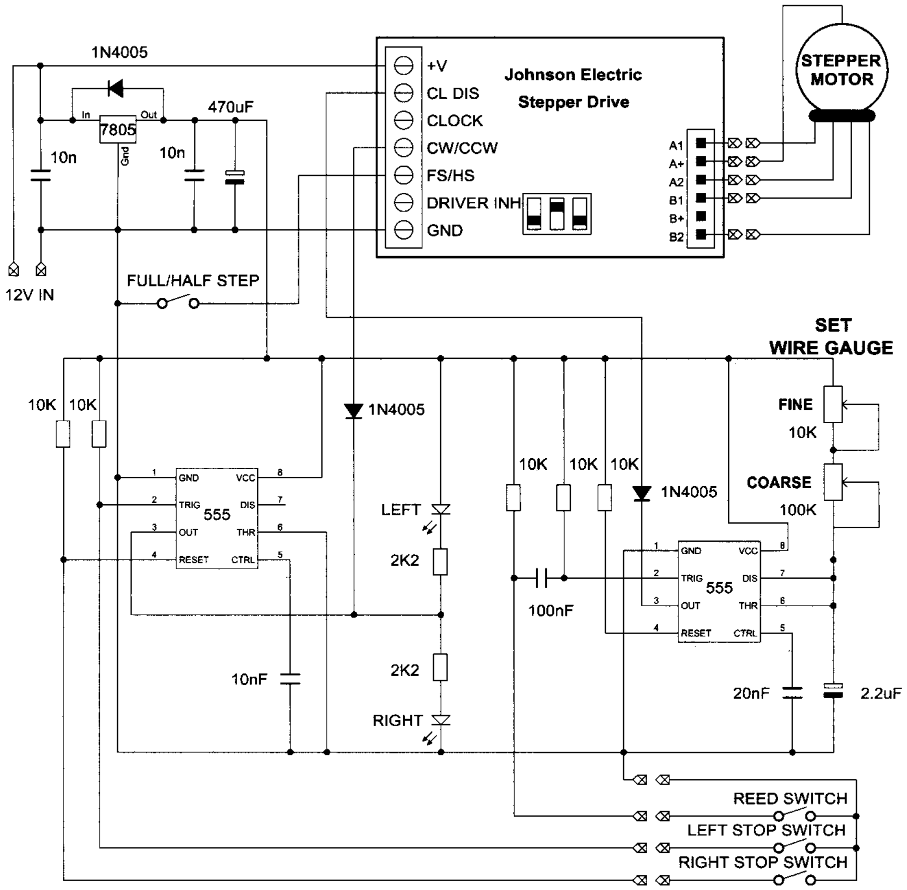
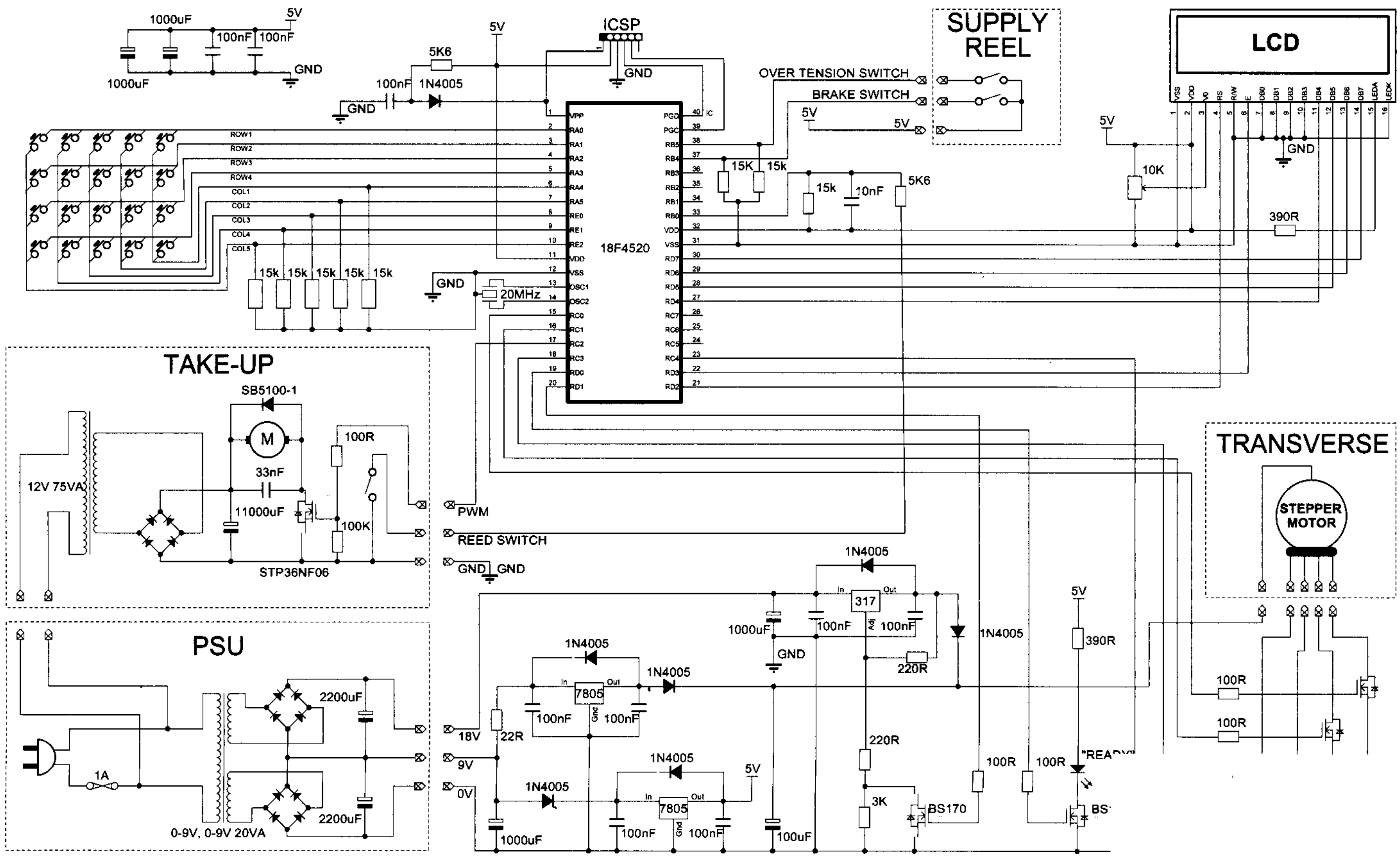


Fig 28.

Transverse controller



PIC controlled coil winder



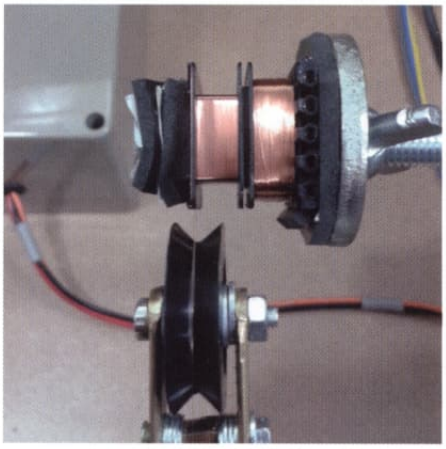
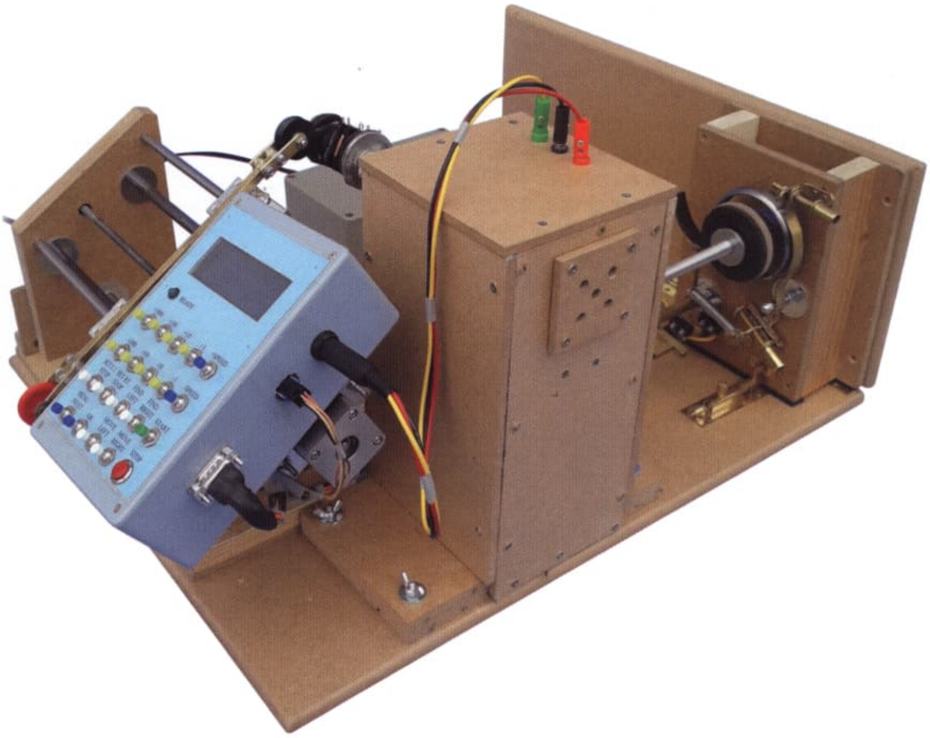


Fig 29. Test coil 0.05mm 300 turns

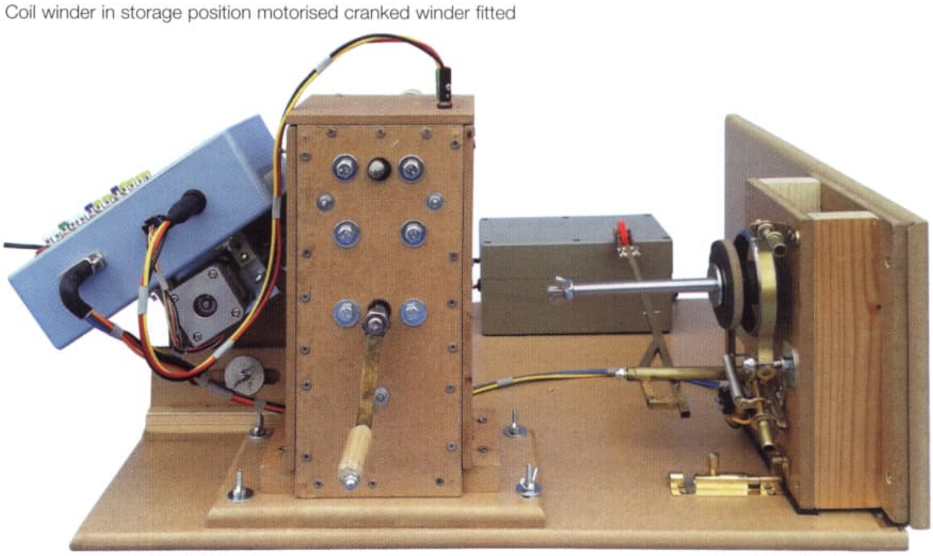
oiling or greasing as well and tended to spray the oil or grease all over the place. The new hand cranked Take-up was built as an effort to correct those problems.

The winding shaft is made from a 10 mm rod with a M10 thread cut into most of it. The unthreaded part sits in bearings. It has 4 gears (fig. 18), 2 x 24 teeth, a 60 tooth and a 80 tooth. They are arranged to give a ratio of 1 : 8.3 which is a good ratio for winding most coils. A handle to drive the Take-up connects to the end of the gear chain, it was fashioned from scrap pieces left over from the rest of the build (fig. 19). For coils using larger diameter wire which would require more torque to wind, the handle can be connected directly to the end of the spindle. All the shafts for the gears are 10 mm rod that runs on bearings at each end. The whole lot is built into a MDF box that will contain any spray from the gears. 5 mm threaded bracing rods and spacers made from 10 mm steel tubes were used to strengthened the MDF box. There are four small magnets equally spaced around the circumference of the winding shaft, they are held in place with epoxy (fig. 20). The magnets activates a reed switch that is mounted on the roof of the box. The pulse that the reed switch produces is sent to the control board so the number of turns can be counted and the carriage moved on. The magnets are quite closely spaced together, if all the magnets had the same pole facing the reed switch, it may not open reliably between magnets, but by arranging each successive magnet to have an opposite pole facing the reed switch produces an alternating magnetic field which gives reliable operation.

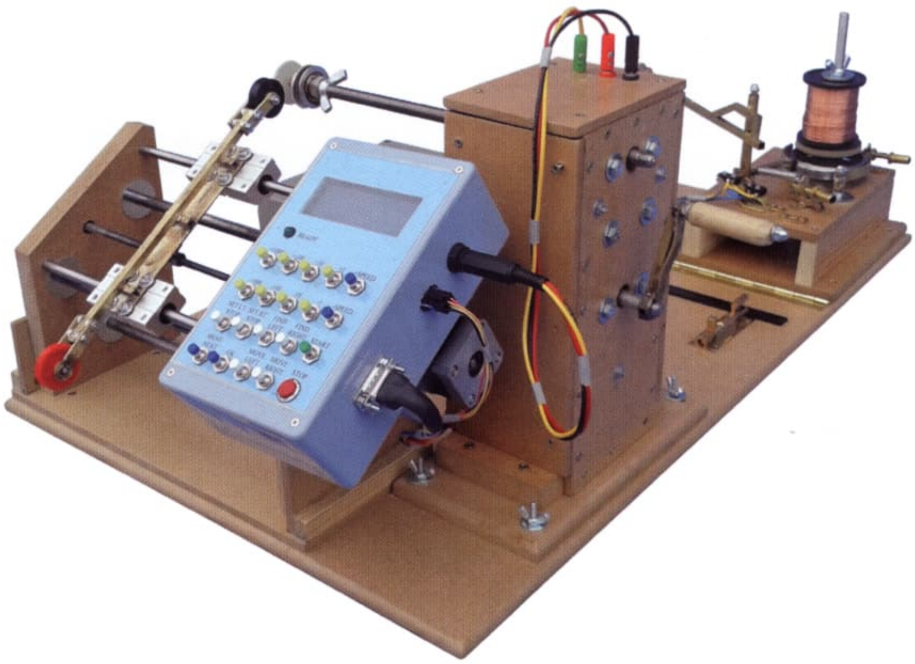
The winding shaft is 10 mm in diameter therefore any coil needs to have an internal diameter of at least a 10 mm to fit on this shaft. For coils with a smaller internal diameter an adaptor was made consisting of a 4 mm screw with its head soldered to the centre of a large washer, a M10 nut was then centred and soldered to the opposite side of the washer. The nut of the adaptor can be screwed onto the end of the winding shaft and locked in place with a wing nut. The small coil former to be wound can then be clamped to the M4 screw with washers and a M4 wing nut (fig. 21).



Coil winder in storage position motorised cranked winder fitted



Coil winder in storage position hand cranked winder fitted



Coil winder in working position hand cranked winder fitted

The Motorised Take-up (fig. 22)
The motorised Take-up is a pretty simple affair, it's made from the workings of a 16V battery drill mounted in a MDF box that also houses its power supply (fig. 23) . Not all battery drills are suitable as some have undesirable axial movement of the chuck. If there is any axial movement of the chuck the coil former will move laterally in relation to the feed pulley which will cause the wire being wound not to be laid as neatly as it otherwise would or may even cause the wire to slip outside a coil former cheek.

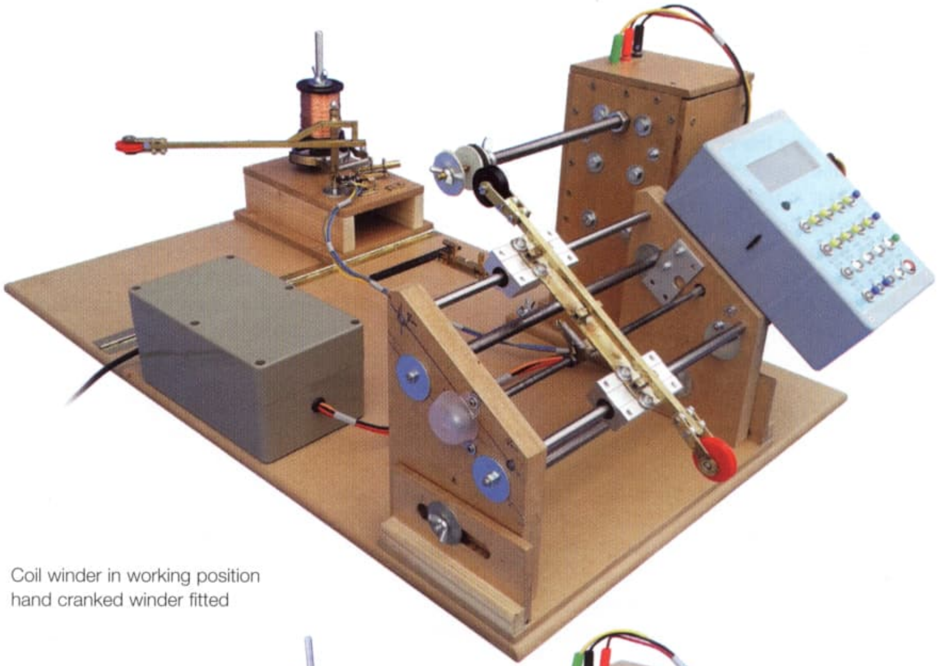
The power supply (fig. 24) is a simple unregulated one consisting of a 12V 75 VA transformer, bridge rectifier and smoothing capacitors. A MOSFET drives the drill motor, PWM from the control unit is applied to the MOSFET's gate to control the speed of the motor. A reverse biased diode and a 33 nF capacitor across the motor terminals keeps the spikes produced by the Motor to a level that the MOSFET can tolerate.

The Controller regulates the speed of the Take-up. To keep stress to a minimum on the wire being wound, the speed of the Take-up is ramped up slowly when starting to wind, it is also reduced slowly when approaching the end of winding and if the speed is changed during winding, the new speed that has been set will take effect slowly.

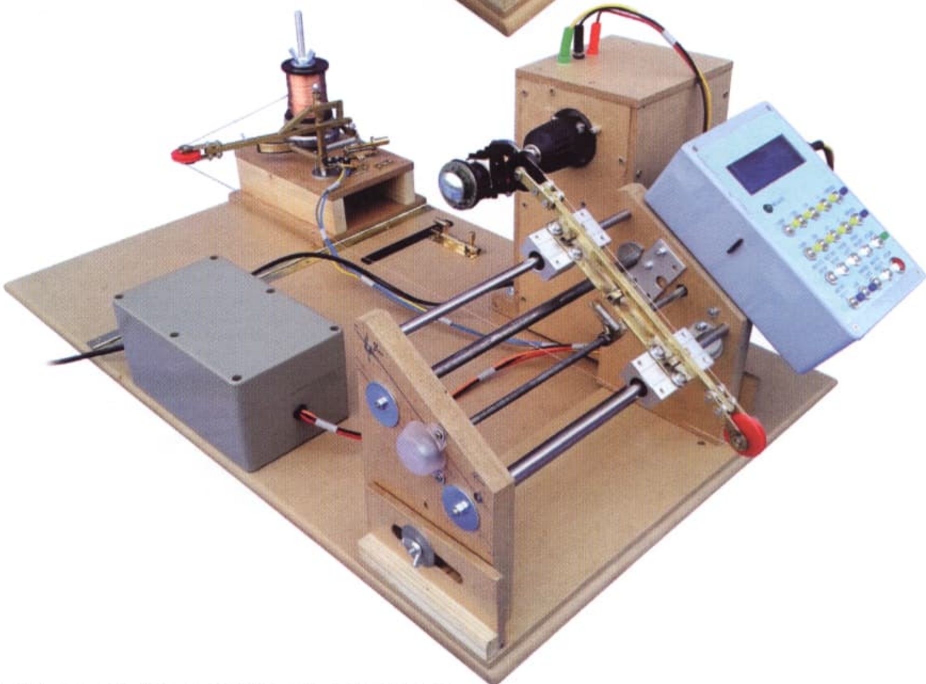
Four magnets spaced equally around the circumference of the drill chuck and a reed switch mounted close to the chuck produces pulses for the turns counter on the control unit.

The Control Unit (fig. 25)
The control board (fig. 26) was built on stripboard using mostly through hole components but some surface mount capacitors were used for decoupling. The layout is a bit all over the place because as the winder developed the circuit changed and parts were both added and removed. The control board is housed in an ABS enclosure and mounted on the right of the Transverse over the Stepper Motor. The control panel legend was done up on a CAD programme, two copies were printed, one on paper that was used as a template to cut out the window for the LCD and to drill the holes required to mount the switches and LED. The second was printed on blue card, a window was cut out of it for the LCD, the card was then laminated. Using a scalpel, holes for the switches and LED were cut out and then the card was stuck to the control panel with double sided tape (fig. 27).

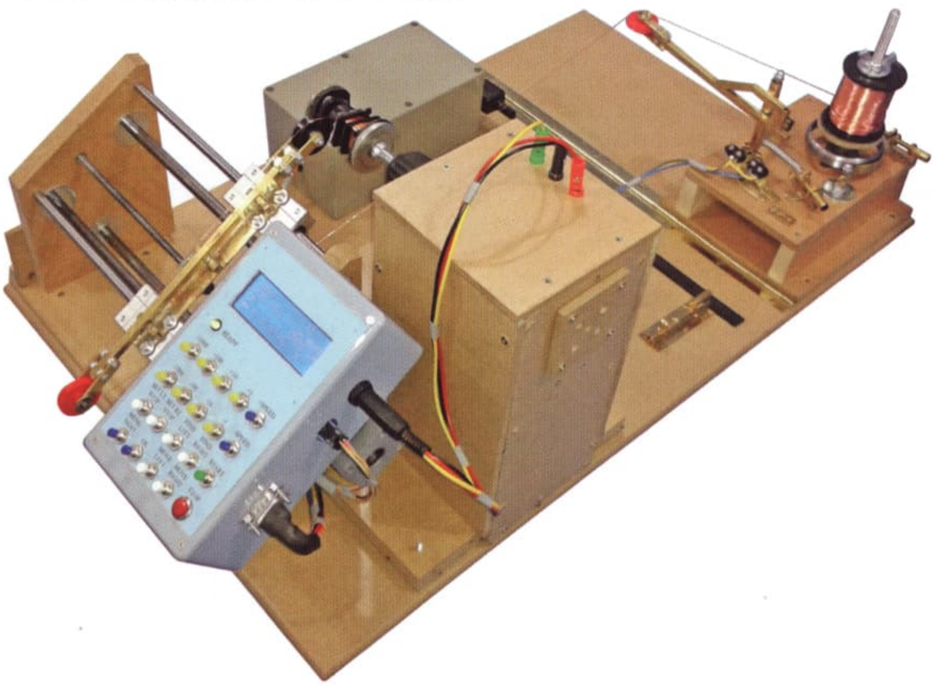
The circuit is based around a PIC18F4520 microcontroller, it controls the Transverse and the motorised Take-up if fitted. On the control panel is a 4 X 5 keypad and a 4 X 20 LCD display. From top to bottom on the LCD the following is displayed; The number of turns wound, the wire diameter in um, the status (any error messages will be displayed here) and the Take-up speed, the width of coil being wound and the direction of travel of the carriage. A "READY" LED, or maybe it should be more aptly named 'Transverse Ready' is also mounted on the control panel, this LED is extinguished while the carriage is moving,



Coil winder in working position
hand cranked winder fitted



Coil winder in working position motorised take-up fitted



Coil winder in working position motorised take-up fitted therefore it should be flashing when winding. Its main use is as a guide when hand winding, for if the LED is off continuously it indicates that the carriage can't keep up and winding should be slowed down.

The basic way the controller works is every time the Take-up makes a full revolution the wire diameter in um is added to a variable that holds the distance the carriage needs to travel, then as 10 um is the distance the carriage travels per step if that variable is greater than 10 the Stepper Motor takes a step and 10 is subtracted from the variable. The Stepper Motor keeps taking steps and subtracting 10 from the variable until the variable is less than 10. The next revolution the Take-up makes, the wire diameter is added to the remainder left in the variable. As an example, if the wire diameter is 116 um, after the first turn of the Take-up 116 will be added to the variable and the Stepper Motor will then take 11 steps (110 um) with 6 um leftover in the variable. The next time the Take-up revolves 116 um will be added to the 6 um in the variable giving a total of 122 um, this time the Stepper Motor will take 12 steps (120 um) with 2 um leftover in the variable and so on. Unlike my old winder this one doesn't have to take the same number of steps for each turn and in this way errors won't accumulate.

The actual way it works is slightly different in that there are four magnets equally spaced around the circumference of the Take-up spindle so the Stepper Motor moves approximately one quarter of a wire diameter each time a pulse is received from the reed switch. A combination of full steps and half steps are used. When the Stepper Motor has taken all the full steps it can, the controller then checks the remainder in the variable and will take another full step or half step if it will bring the carriage closer to where it should be, even if it means overshooting slightly. By doing this the carriage is never more than 2 um from where it should be, this of course does not take into account the mechanical tolerances which are much greater.

When hand winding ones attention is on the job at hand and if something were to go wrong it would be seen immediately and corrected, however the same can't be said if winding in automatic mode, therefore it would seem prudent while in automatic mode for the controller to monitor the winder as best it can and take action if something is amiss.

If using the motorised Take-up, the controller monitors the brake switch, over tension switch and the pulses coming from the reed switch. If the brake or over tension switch is activated while the motorised Take-up is active, winding will be stopped and "BRAKE ON" or "OVER TEN" will be displayed respectively in the status area of the LCD. If no pulses are detected coming from the motorised Take-up while it is active, winding is stopped and "NO PULSE" is displayed in the status area of the LCD.

The user can change the speed of winding at any time but if the controller detects that the carriage is not able to keep up with the Take-up, the controller will take over control of the speed and reduce it to a level where the carriage can keep up. The controller then sets this speed as the maximum and "TOO FAST" will be displayed in the status area of the LCD to indicate why the speed was reduced. From then on the user can decrease the speed but can not increase it above the set maximum. The maximum speed can be reset via the menu.

When winding larger coils I rarely wind them in one go, not spending more than a half hour at a time, it is therefore important that when the winder is shut down or if power is lost that all relevant variables are saved, so when the winder starts up again it starts exactly where it left off. This is achieved by the controller monitoring its own power supply and once it detects that it is falling a subroutine is called to save all the variables before power is totally lost. If power is lost while the Take-up is active, once power is then restored "POWER INT" will be displayed in the status area to indicate that power was lost while winding and the winder will remain inactive until the "START" button is pressed.

To set up the winder, first, using the key pad the speed and the wire diameter are set, these can be changed at any time even while winding is in progress. ECW is sold by the diameter of the copper, the insulation adds to the actual diameter of the wire accordingly when setting the wire diameter an allowance must be made for its insulation. The wire diameter can be set to any value from 1 um to 1500 um. Via the menu the turns counter is reset to zero and the number of turns required is set. The turns counter will count up to 60,000 and the turns required can be anything up to this value. 60,000 should be more than sufficient as the largest coil that I have wound so far was a speaker field coil from a "McMichael Twin Supervox" with just over 30,000 turns and it is unlikely that I will come across any larger than that. Also via the menu the carriage is set-up so the controller knows where the coil is located. This is done by using the " MOVE LEFT" and "MOVE RIGHT" buttons to first line up the centre of the feed pulley with the left end of the coil and then pressing the "SET LT. STOP" button, the controller now knows that this is the left hand end of the coil. The feed pulley is then lined up with the right end of the coil and the "SET RT. STOP" button pressed which tells the controller that this is the right hand end of the coil. The carriage is now set up and the coil width is displayed on the LCD. The coil width is calculated as the distance the carriage travels plus one wire width. The left or right stops can be changed at anytime through the Menu. To aid adjusting the end stops after they have been set up the "FIND LEFT" and "FIND RIGHT" buttons will move the carriage to the left and right stop respectively. The winder is now set up and if using the motorised Take-up will begin to wind as soon as the "START" button is pressed or if using the hand cranked Take-up just start turning its handle. If winding with the hand cranked Take-up it is not necessary to set the turns required or the speed.

The Power Supply (fig. 28)

As there wasn't enough room to fit all the power supply components in with the controller, the transformer, rectifiers and smoothing capacitors as well as the IEC socket to supply the motorised Take-up are contained in a separate enclosure towards the rear of the winder.

The transformer is a 0-9V, 0-9V, 20 VA. Each secondary is rectified and smoothed, they are then connected in series to give unregulated outputs of approximately 12V and 24V. All the regulators are on the control board. To reduce dissipation separate regulators were used for the Stepper Motors 18V and 4.5V supplies. A LM7805 fed via a dropper resistor from the 12V supply provides the 4.5V holding voltage for the Stepper Motor and a LM317 fed from the 24V supply provides the switched 18V for the Stepper Motor. To keep any nasty spikes that may be produced by the stepper motor away from the microcontroller another LM7805 also fed from the 12V supply provides 5V for it and the LCD.

The Base Board

All sections of the winder are mounted on a base board made from 12 mm MDF measuring 460 mm wide by 730 mm depth, the rear 190 mm of the board on which the supply reel is mounted is attached with piano hinge so it can be folded up to make its footprint smaller for storage. A brass cranked bolt locks it in the storage position while its own weight is sufficient to hold it open while working. The Supply Reel, Transverse and Power Supply are attached to the Base board with wood screws. To allow an easy exchange of the Take-ups they fit onto four M4 screws on the base board and are fastened in place with wing nuts.

Final Thoughts

Using a PIC makes it easy to set-up, increases its accuracy and can make the winder fully automatic. Different modes of winding could be added if needed, for example one for layer winding where the winder stops at end of each layer to facilitate insertion of interlayer insulation or one for pyramid winding where the number of turns in each successive layer is reduced. However if I hadn't gone down the PIC road I would have no qualms about using a controller similar to the old one which gave perfectly acceptable results in my old winder.

No build is ever perfect and no doubt as it gets used things will come to light that could be done better, even now if I had to build it again, I would use a larger lead screw maybe a M8 or M10. The M6 that I used was chosen for it's 1mm pitch which made the calculations the controller makes easier but because of the length it has to span it is slightly flexible although this doesn't cause any real problem.

I haven't had a need to wind any coils on it yet, but I did some test coils to check it in both hand cranked and automatic mode. One of the coils is shown in fig. 29 it is 300 turns of 0.05 mm wire, wound on the left hand section of the former. From the results of those tests I have no doubt that it will be well able for anything I need to wind, although I don't know which Take-up I will be using the most as each has its own merits, only time will tell.

More variations on a theme by Robert Darwent

I previously wrote an article on this series of portables entitled "Variations on a theme: The Bush MB60 family" which appeared in the Winter 2010 issue of The Bulletin. That article ended with the final paragraph speculating on the possibility of further model variants out there waiting to be unearthed, as it were. I should now like to report on a further little known model and a subtle variant of an already known model to add to the series.

A long wait, then two at once!
Readers of my earlier article will be aware that there are three export models in this family of portables which are considerably scarcer than the other models in the series. Those models being the EBM60, the ETR82 and the ETR92. Those three sets differ most notably from the more common domestic models by offering short wave ranges, specifically two short wave bands plus the medium wave band.

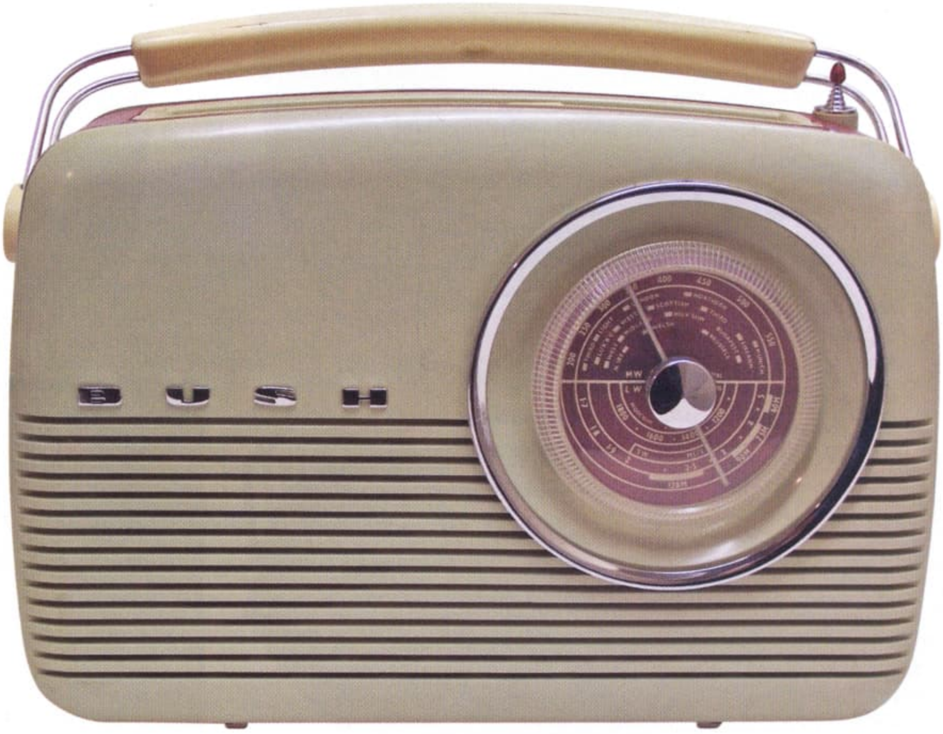
To my knowledge in the past eighteen months or so roughly half a dozen of the three export model types have come up for purchase on online auction sites, three of those examples being ETR92's. The ETR92 I have had in my collection for several years has an earphone socket and associated escutcheon fitted on the left hand side when viewing the set from the front, as have all other examples of the ETR92 I have previously come across.

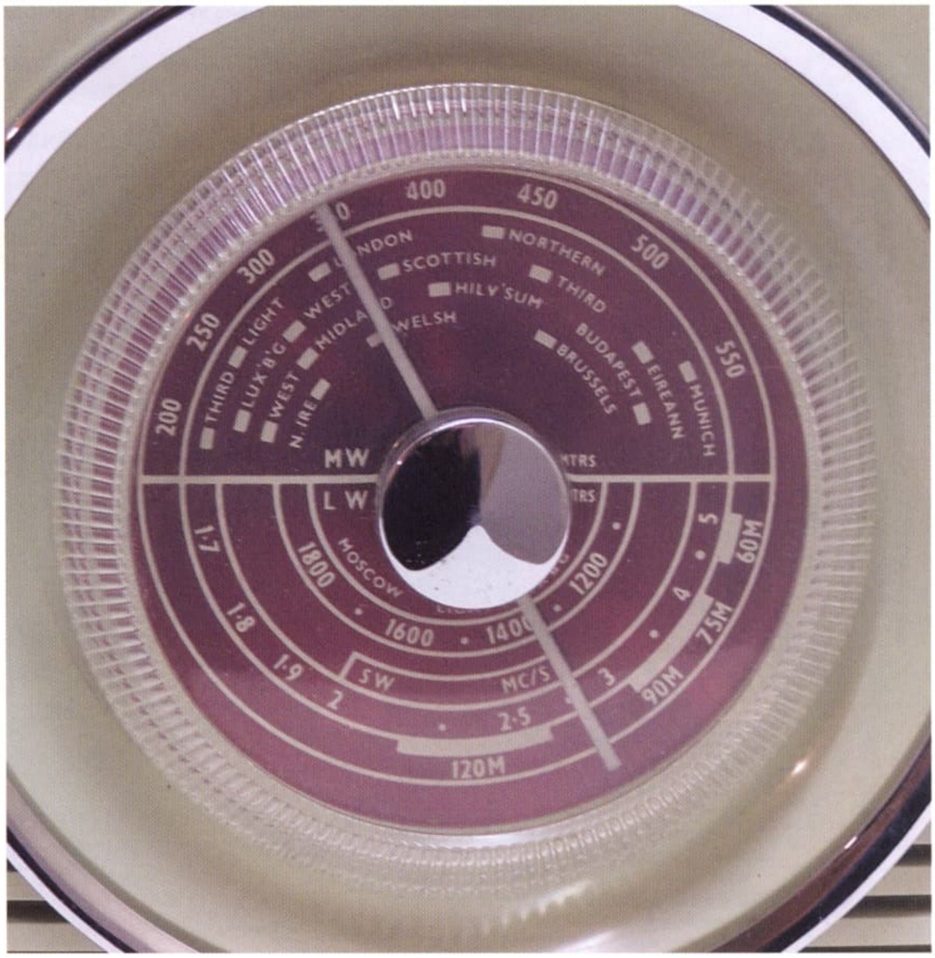
However, a close scrutiny of the online examples showed a couple of the auction ETR92's did not have this socket. I obtained the serial numbers for all three sets from their respective owners and together with earlier serial numbers from my own ETR92 and others I knew about, saw that those with an earphone socket all had a higher serial number (>8000) compared to the two sets that did not have the socket (<4000). Subsequently, I was fortunate enough to obtain one of the two ETR92's without an earphone socket to add to my collection.

Its hard to infer anything with certainty from such a small sample, but it's obvious that the ETR92 must have received the inclusion of an earphone socket sometime during its production run. This was also the case with the TR82C model using OC-series transistors. From dates obtained on electrolytic capacitors used in all the models that I have with an updated earphone chassis of one sort or another, this would appeared to have happened around 1961.

I also carried out an internet search with the intention of trying to find further images of the ETR92 variant without an earphone socket. But rather unexpectedly instead, I came across a model on an image hosting website with a similar name that I hadn't heard of before.

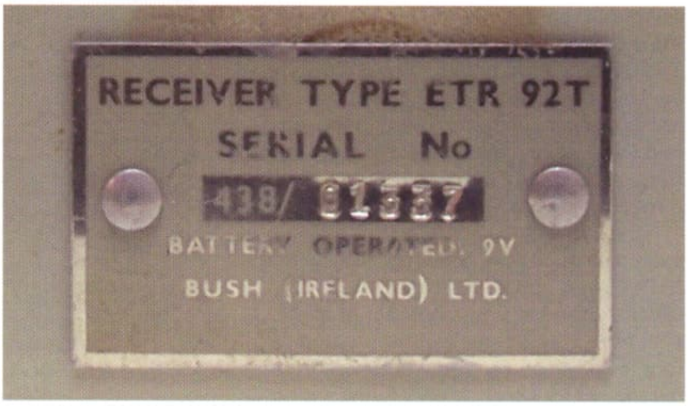
The Bush ETR92T
There were several good close-up images showing a set which I initially wrongly assumed to be a "marriage" of two or three of the known models in the series. It will be appreciated that the majority of the plastic case parts and the various

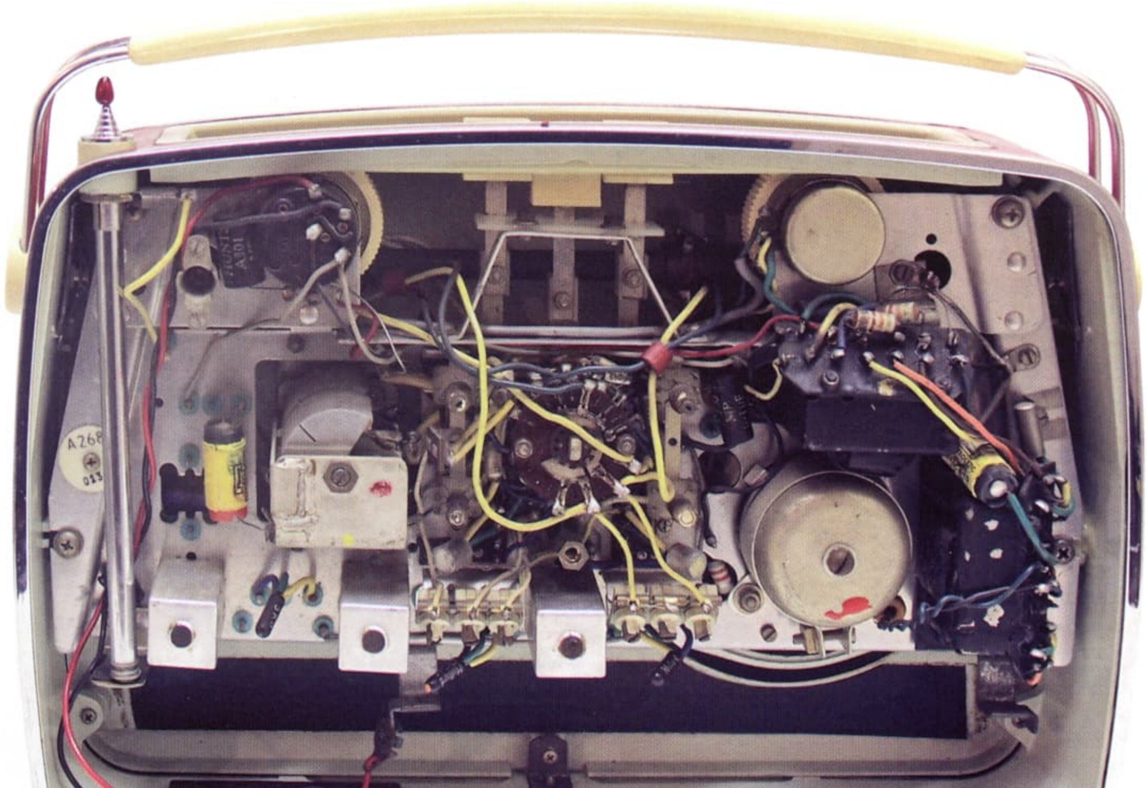





BUSH


BUSH


RECEIVER TYPE ETR 92T
SERIAL No
438/
BATTERY OPERATED. 9V
BUSH (IRELAND) LTD.



chassis themselves are interchangeable between the different sets in the series.

My sceptism was because of the colour combination used by the ETR92T. It has the same light blue/green coloured plastic case plus the chrome trim and "B U S H" lettering that is found on the familiar TR82C. But the middle section instead of being blue has a red rexine covering, as used by the MB60 and EBM60 battery valve models.

But after contacting the owner of the images and then much later acquiring an example of the ETR92T for my collection myself from another source, there is now no doubt that the set is indeed a genuine model. However, I still find the colour scheme a strange choice, hence my immediate thoughts that it had been assembled by someone using spare parts.

The type/serial number plate underneath the middle of the case states "Bush (Ireland)" and from information given on a quality control label still attached inside the set, that the model was made at Bush's factory based in Dublin's northern suburb of Whitehall. Like the colour scheme this fact is also unusual, as far as I'm aware all the other models in the series were produced at Bush factories in England.

The set has a dial offering long wave, medium wave and one short wave band from 1.7 to 5.0 MHz with the three wavechange buttons labelled simply L, M and S. This short wave range is considerably lower than those offered on the three export models mentioned earlier, so presumably the "T" suffix in ETR92T logically stands for "trawler band" (made in Ireland for people in coastal areas).

Internally, the chassis appears to be derived from the ETR92 export variant without an earphone socket. Apart from very minor differences in the number of coils and trimmers fitted due to the different wavebands offered, it looks to be virtually identical.

As with the more familiar domestic sets in the series, the model specifies the use of a 9 volt Ever Ready PP9 or equivalent rather than the 6 x D cells used by the ETR82 and ETR92. This is despite also sharing the "E" prefix with those earlier models, which Bush usually uses to denote an export set.

The battery choice would rather suggest that the ETR92T could have been produced as a domestic model, since the main reason for specifying D cells over the PP9 was largely because of the limited availability of the battery overseas. Perhaps Bush produced the ETR92T specifically for the Irish market and gave it the "E" prefix for that reason. However, this is just speculation on my part, I have no definitive proof.

Model	Type	Chassis	Band Buttons	Case	Rexine	Trim	Ear	Released
1. MB60	237	A99 (1st)	Long, Medium	Light grey	Red	Brass*	No	c.1957
		(2nd)	Long, Medium	Light grey	Red	Brass*	No	c.1958
2. EBM60	240	A100	M, S1, S2	Light grey	Red	Brass*	No	c.1957
3. TR82B	345	A177 (1st)	Long, Medium	Cream*	Brown	Brass*	No	c.1959
		(2nd)	Long, Medium	Cream*	Brown	Brass*	No	c.1960
		(3rd)	Long, Medium	Cream*	Brown	Brass*	No	c.1961
4. TR82C	346	A177 (1st)	Long, Medium	Blue/green	Blue	Chrome	No	c.1959
		(2nd)	Long, Medium	Blue/green	Blue	Chrome	No	c.1960
		(3rd)	Long, Medium	Blue/green	Blue	Chrome	No	c.1961
		(4th)	Long, Medium	Blue/green	Blue	Chrome	Yes	c.1962
5. ETR82	355	A190	M, S1, S2	Blue/green	Blue	Chrome	No	c.1959
6. ETR92	421	A253 (1st)	M, S1, S2	Blue/green	Blue	Chrome	No	c.1960
		(2nd)	M, S1, S2	Blue/green	Blue	Chrome	Yes	c.1961
7. **ETR92T**	**438**	**A268**	**L, M, S**	**Blue/green**	**Red**	**Chrome**	**No**	**c.1960**
8. VTR103	462	A287	LW, MW, VHF	Light cream	Tan	Chrome	Yes	c.1961
9. TR82D	508	A177 (4th)	Long, Medium	Light cream	Tan	Chrome	Yes	c.1962
10.TR82C Mk.II	528	A349	Long, Medium	Blue/green	Blue	Chrome	Yes	c.1963
11.TR82D Mk.II	530	A349	Long, Medium	Light cream	Tan	Chrome	Yes	c.1963
12.VTR103C	622	A287	LW, MW, VHF	Blue/green	Blue	Chrome	Yes	c.1964
13.TR82CL	653	A458	LW, MW, 208	Blue/green	Blue	Chrome	Yes	c.1964
14.TR82DL	655	A458	LW, MW, 208	Light cream	Tan	Chrome	Yes	c.1964

(*) Bush in their sales literature described the colour as "Regency cream" and the trim as "Florentine Bronze"

Chassis		Valve and/or semiconductor line-up used									
1. A99	(1st)	DK96	DF96	DF96	DAF96	DL96					
	(2nd)	DK96	DF96	DF96	DAF96	DL96					
2. A100		DK96	DF96	DF96	DAF96	DL96					
3. A177	(1st)	OC44	OC45	OC45	OC72	OC72	OC72	OC72	OA70		
	(2nd)	OC44	OC45	OC45	OC71	OC78D	OC78	OC78	OA70		
	(3rd)	OC44	OC45	OC45	OC72	OC81D	OC81	OC81	OA70		
	(4th)	OC44	OC45	OC45	OC72	OC81D	OC81	OC81	OA70		
4. A190		DK96	OC45	OC45	OC71	OC78D	OC78	OC78	OA70	OC72	OA81
5. A253	(1st)	OC170	OC170	OC45	OC45	OC71	OC81	OC81	OA70		
	(2nd)	OC170	OC170	OC45	OC45	OC71	OC81	OC81	OA70		
6. **A268**		**OC170**	**OC170**	**OC45**	**OC45**	**OC71**	**OC81**	**OC81**	**OA70**		
7. A287		AF114	AF115	AF116	AF116	AF116	OC71	OC81D	OC81	OC81	OA90 OA71
8. A349		AF117	AF117	AF117	OC71	OC81D	OC81	OC81	OA90		
9. A458		AF117	AF117	AF117	OC71	OC81D	OC81	OC81	OA90		

Model, type and chassis tables

In view of the ETR92T, which is model type 438 and uses chassis type A268, plus the second variation of the ETR92 model coming to light I have reworked my earlier tables to include them both.

At the same time I have taken the opportunity to reclassify the models using Bush's type numbering system. All other variations are now more correctly given as production runs (1st, 2nd, etc) or updates of the initial model type, rather than new models in their own right. I hope the tables will be self explanatory in this regard.

From viewing the tables, it will be seen that there are 14 model types and 9 chassis types. Counting all the (known) variations gives a total of 21 distinct sets in the series.

Further model variants?

Again, the list of model types given here may not be exhaustive and there may be further little-known variants out there. Any information regarding such sets not covered here would be most welcomed by the author. (robert.g0uhf@gmail.com)

Repair of an EKCO A320 from 1957

by Gary Tempest

This tired looking radio has been in regular use for decades by my Yoga Gurus who like the 'valve sound'. But lately it had started to have an annoying crackle which was thought to be the volume control.

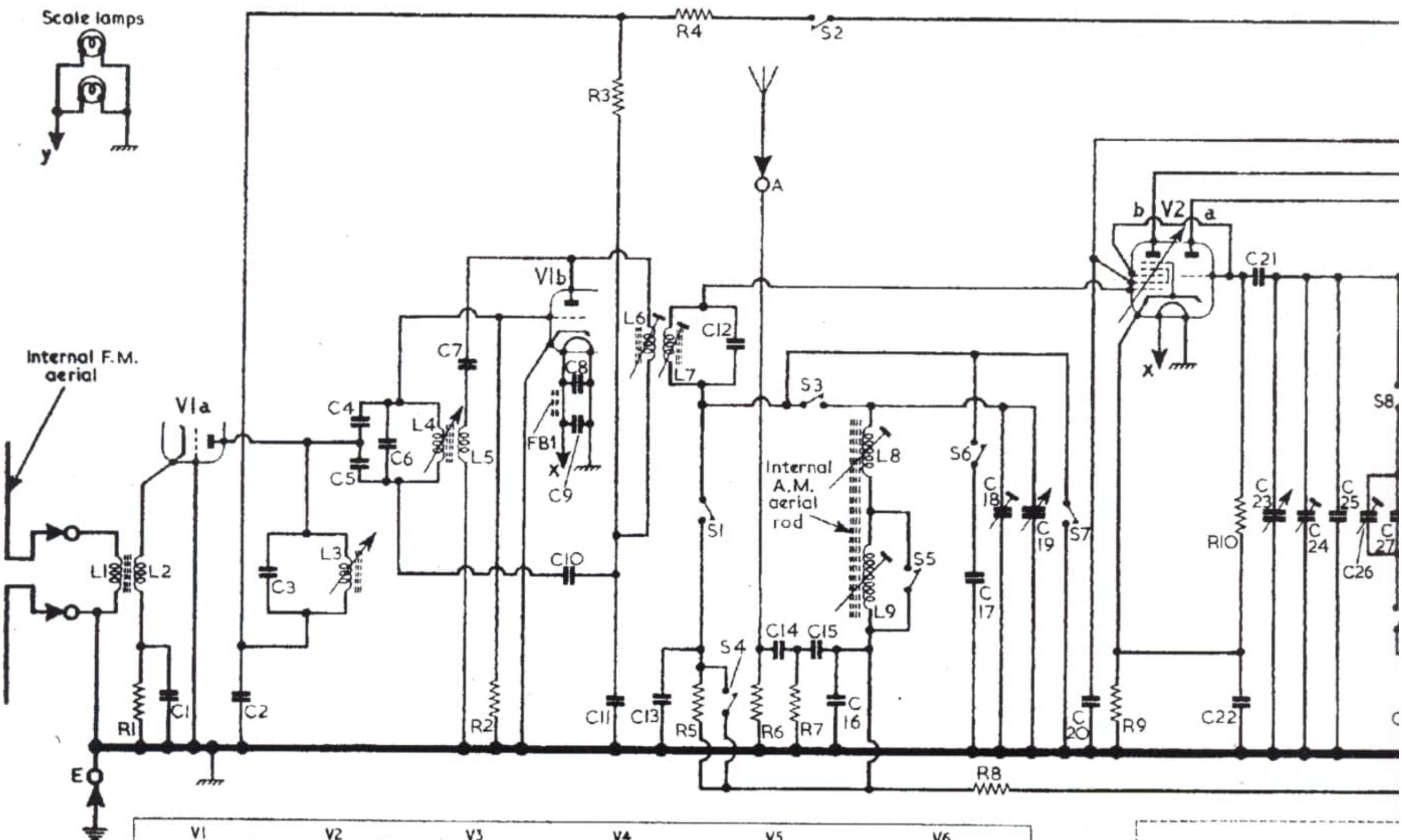
When I looked inside I was amazed as it appeared untouched since it was made. Even all the valves were by Mullard and equally dirty so I think they are the originals.

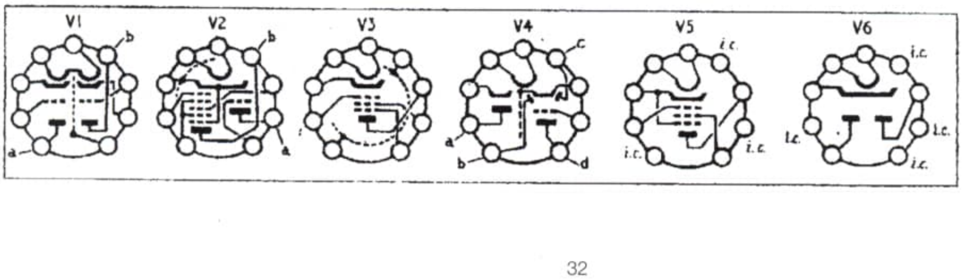
I removed the chassis, gave it a quick clean and then made up a simple stand. Once I could look underneath it confirmed that it had never had a soldering iron on it since new.

Faults

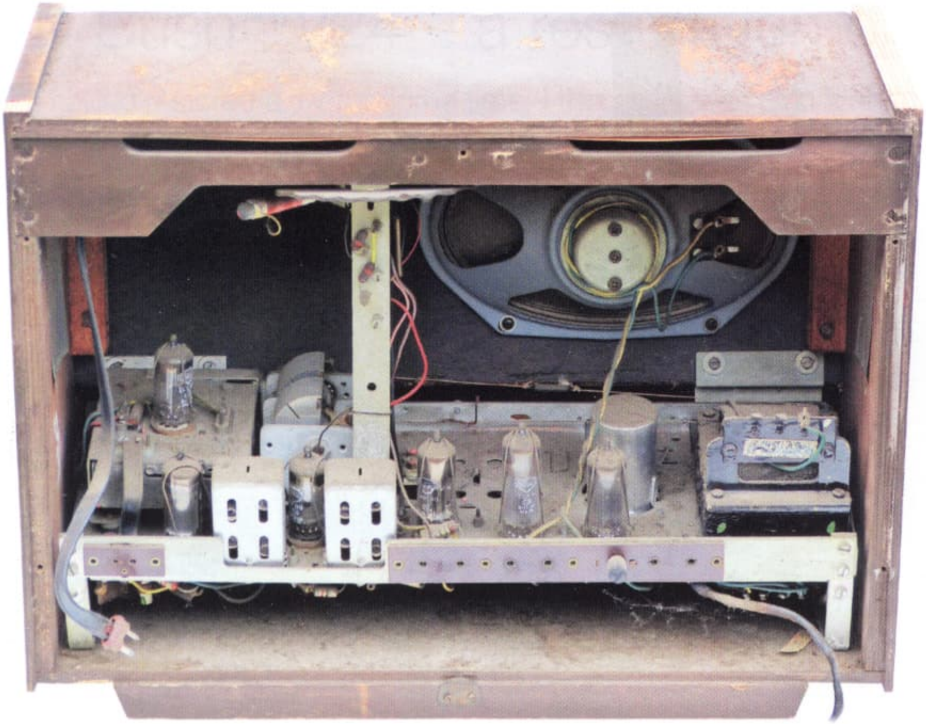
First thing was to check the fuse in the plug and as I had guessed it was 13A so that was corrected with one of a more appropriate size.

The set was working on all wavebands and the volume (and tone control) seemed fine which I was pleased about. Sourcing a new one with the correct dual concentric shafts wouldn't have been easy. And then I spotted the problem: arcing could be seen from a tag, carrying HT (S10) on the





Circuit diagram of the E
mains transformer. Th
applied from



rear switch wafer, to the earthed studding.

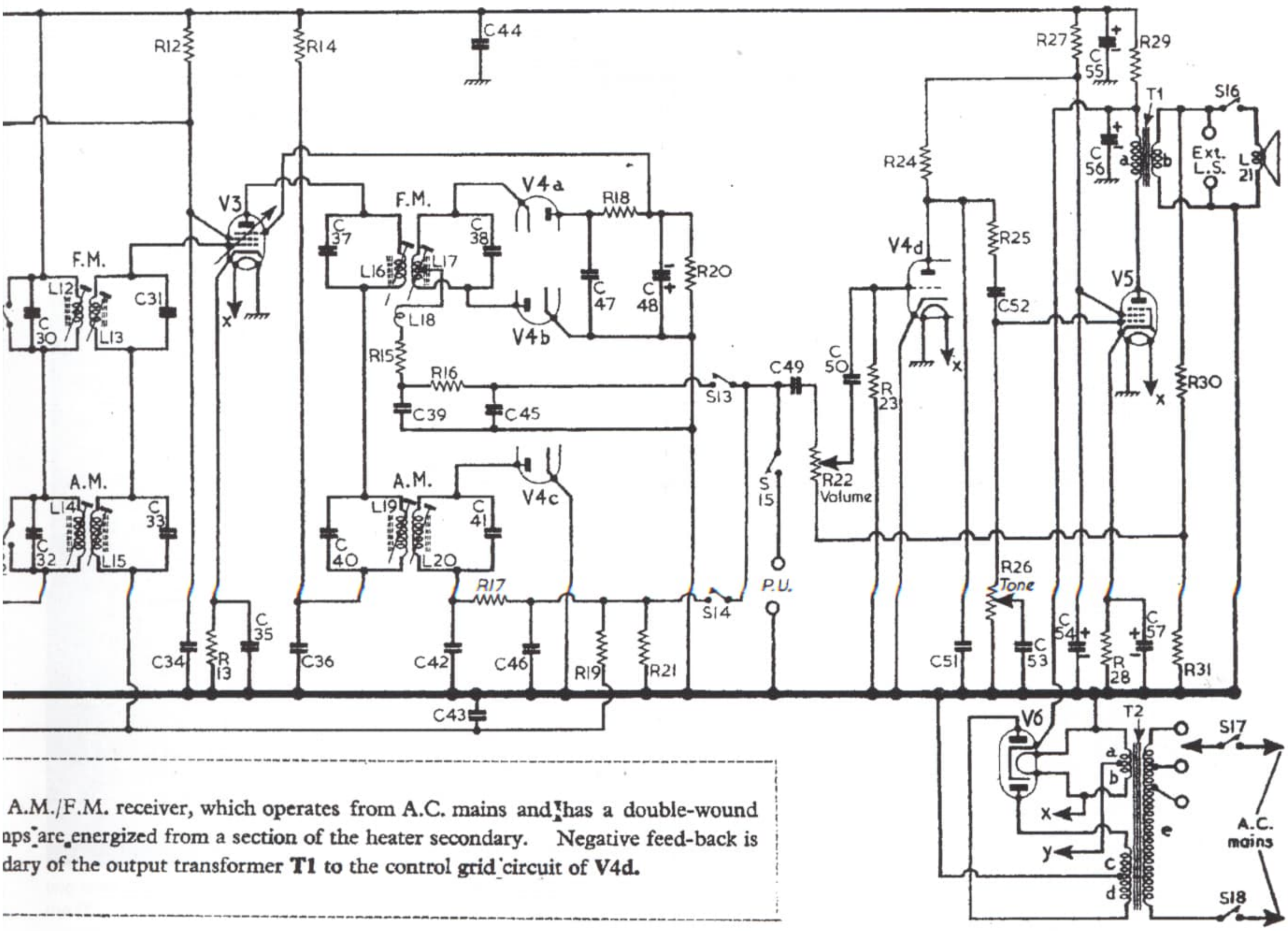
The switch was very dirty and black so I expect the tags and rotors were silver plated. I first gave it a clean with DeOxit switch cleaner and a stiff brush which stopped the arching. But possibly silver migration had occurred; a problem in some of the silver mica capacitors, in US radio IF transformers, of the same vintage. Using a bent rat tail file I scrapped in-between the tag and the stud on both sides of the wafer, cleaned away the dust and there hasn't been a problem since.

Moving on to the coupling capacitors for the AF pre-amp and the output valves and both were bad. The EL84 grid had positive volts and snipping a lead on that to the grid (C52) dropped the cathode volts by a third and the current from 60 mA to a more correct 40. The valve obviously still had emission so I didn't bother to remove and test it.

The hum was very low and the power supply electrolytic C55 and 56 (a 50 + 50 micro F) had no bulges but was a little warm to the touch; about 31°C on a digital thermometer. It was probably fine but just to be sure I measured the DC current in the easy to disconnect earth lead and it was only 70 micro A with a lowly ripple current of 2.3 mA true RMS. I imagine 500 mW or so is enough to warm it a little particularly as it's a compact can. So not having a replacement I left it to continue on. Whilst I was at it I measured the DC leakage current of C54, the EL84 screen and AF stage decoupling, and that measured zero.

Nearing the end of this 50 year+ service, I measured the valve voltages and compared them to those given on the Trader Sheet and they were close enough not to give concern.

Finally, I gave all the valves a waggle and the EL84, that runs very hot, made lots of crackling noises when listening



A.M./F.M. receiver, which operates from A.C. mains and has a double-wound
mps are energized from a section of the heater secondary. Negative feed-back is
dary of the output transformer **T1** to the control grid circuit of **V4d.**

to a station. So now I did remove it and cleaned all the blue oxidised pins and squirted a little DeOxit into the base. I was shown, decades ago, to clean the valve pins by gently scrapping with a pointed scalpel blade and it has always worked for me. When the valve was replaced it could now be waggled with silence.

The cabinet

As can be seen in the pictures it is very tatty but from being kept indoors and used it had no sign of woodworm.

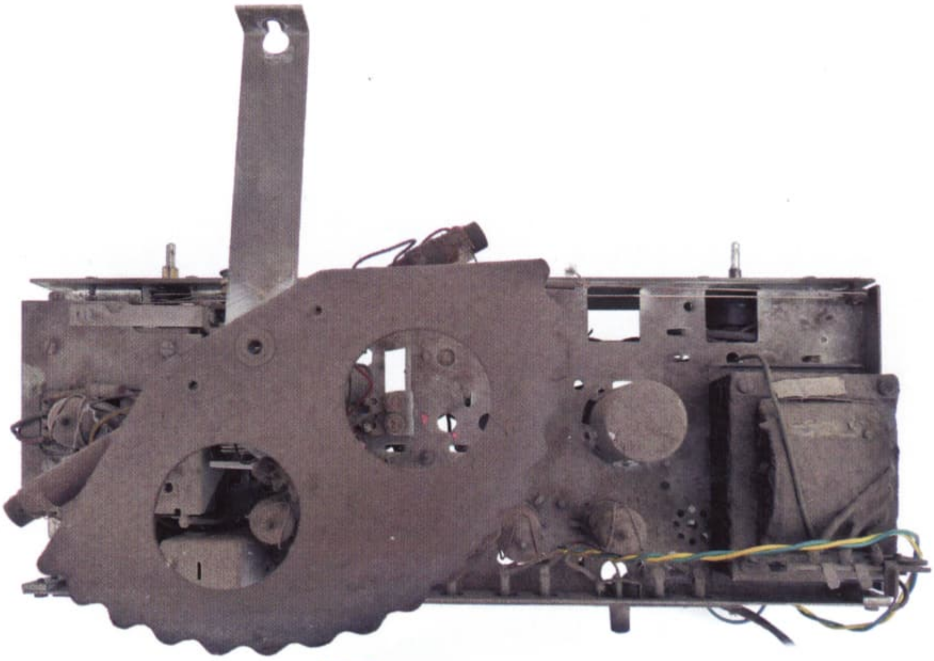
I removed about 1/8" of dust from inside and cleaned the waveband scale which was still perfect. I did consider touching up the top and edges but 'talked' myself out of it.

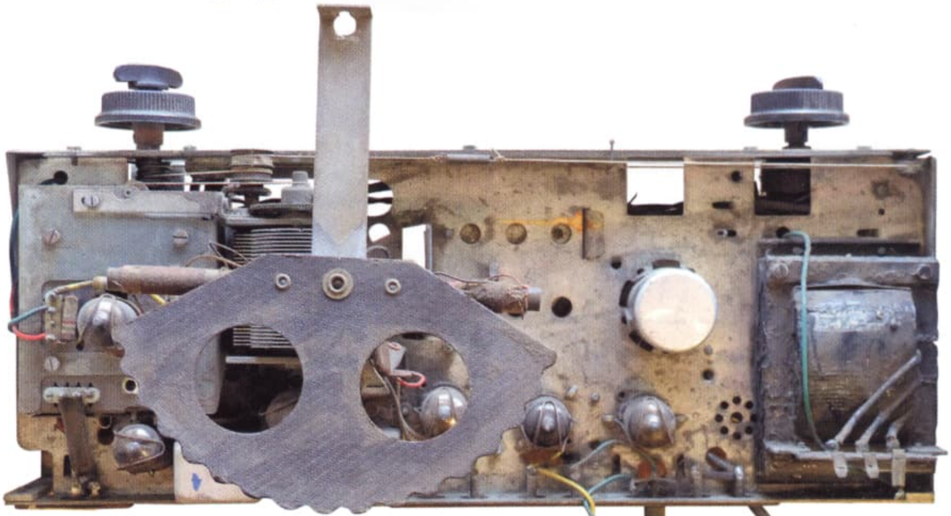
Conclusions

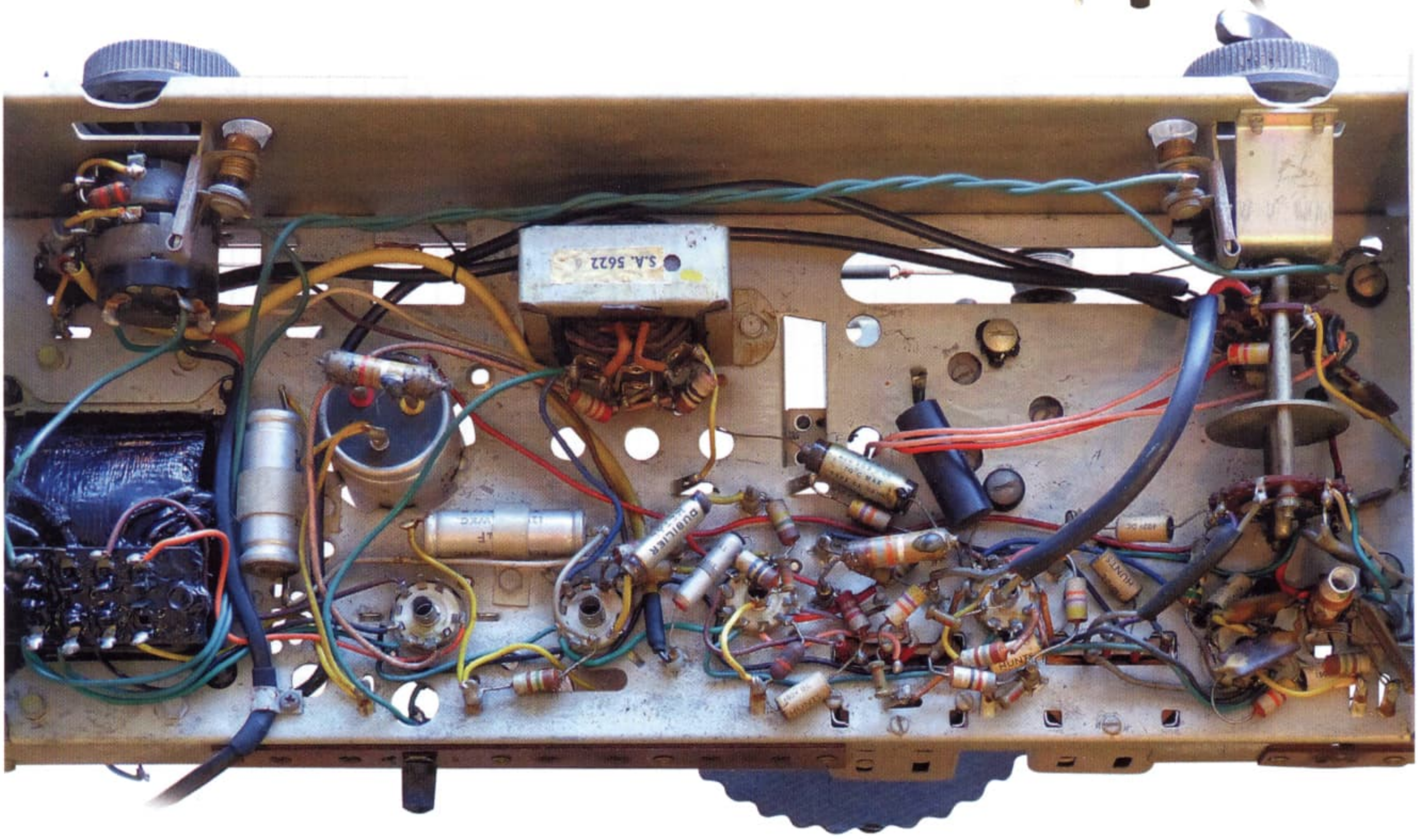
This is not my usual era of radio to work on and I was surprised that when it came to me it was still working after 57 years with nothing having been done to it. A first thought was possibly I was working at Ekco at the time it was made. But thinking about it I may have just moved on to a job and training with a branch of Pye.

Once I had put right the faults I was to find that the radio works very well on its internal aerials and on AM the rotatable ferrite rod is an asset.

They even correctly sized the mains transformer as this runs just slightly warm. Well done Ekco!



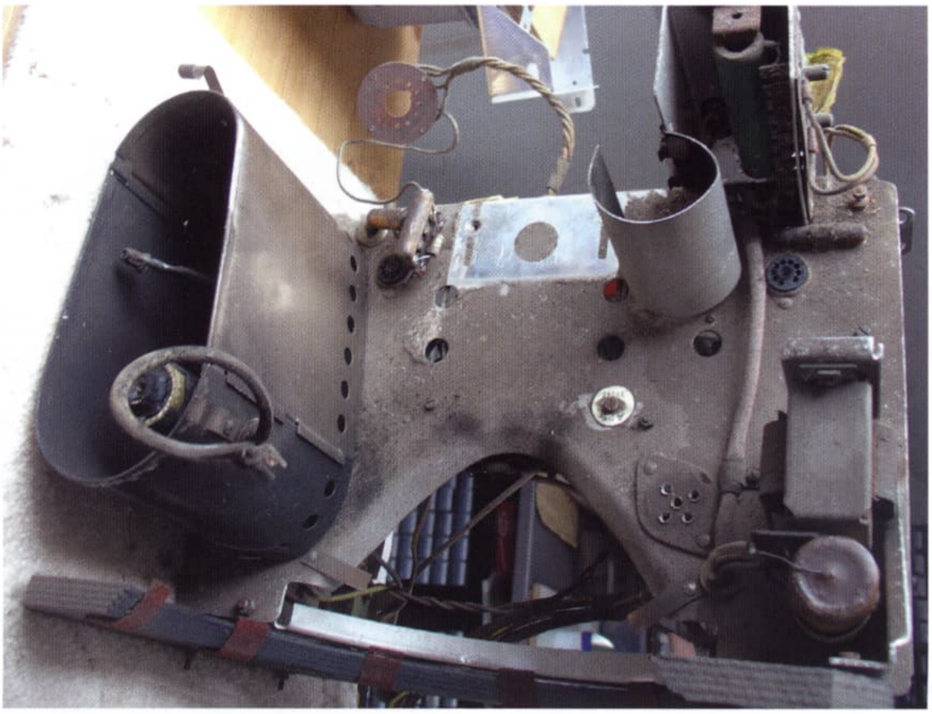




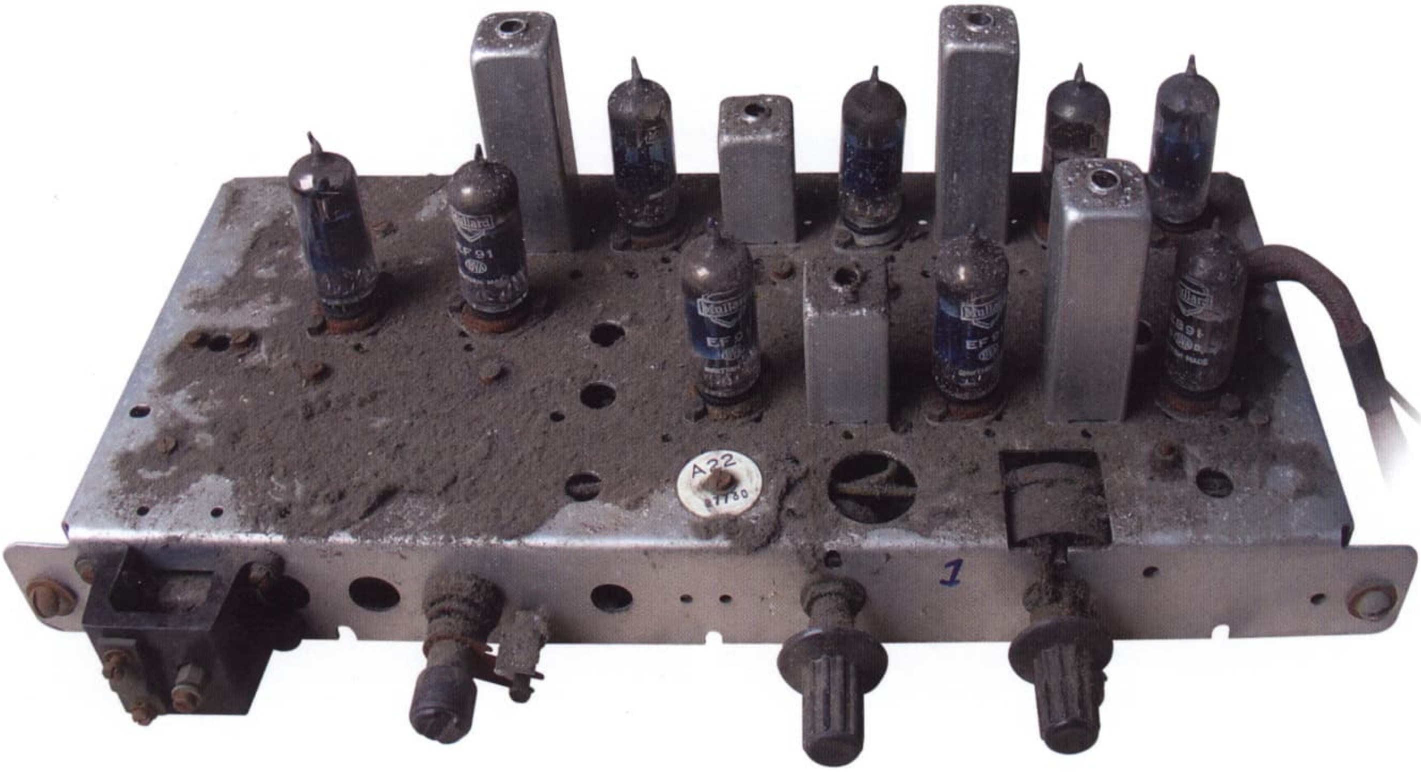
My Bush TV24 – a restoration or rebuild? by Ian Liston-Smith

Not having restored a TV for some time, I thought it was high time to tackle one of the four Bush TV24s piled up in the garage that I had accumulated over recent years. But which one should I tackle?

Dodgy LOPT with 'hump'



Main chassis with tube removed



The dust-covered Mk I RF/IF chassis

I had indeed gathered four TV24s in the past decade; one had a reasonable cabinet, one had a good rubber mask and one had a good back. But would any have a good tube...? One was a TV24A so had a completely different main chassis, and one was a TV24C with band I and III tuner, with the extra switches on the side. The other two were both MK1s with EF91 valves in the RF/IF chassis, so it was the least worst of these that I chose as my challenge.

As can be seen from the photos, it was in a bit of a sorry state. Where does all that goo and fluff come from? Considering its condition I decided on a complete strip-down and rebuild – a fairly daunting task.

To begin, I dismantled the RF/IF strip. After removing all the IF transformers I opened them up in turn to inspect the contents and clean the cans. The bare chassis got a cycle in the dishwasher which bought it up like new in preparation for mounting mostly new components, apart that is, from the inductors, potentiometers (and the main chassis wire-wound resistors).

I opened up all the set's potentiometers to clean and lubricate and found the very fine wire in one of them had broken and was unravelling, so selected a spare from another set and cleaned that.

I've restored a couple of Bush TV22s. They have the smaller nine-inch tube but of course are housed in the iconic bakelite cabinet. The circuits of the TV24 and TV22 are for all practical purposes identical. But the TV22 is much easier to handle - particularly when operating it out of the cabinet for tests and adjustments – because the tube is well supported in the chassis and held securely around the screen perimeter with a metal strap.

The tube of the TV24 on the other hand, rests in a cut-out in the wooden panel bolted to the front of the chassis, and when out of its cabinet, the tube clamp near its base is all there is to prevent it from falling forward. There are holes in the wooden panel which I'd strongly recommend are used to string the tube in place securely while working with the main chassis out of the cabinet.

More deconstruction

Time to de-construct the main chassis, starting by carefully removing the tube. The scan coils often get firmly stuck to the glass neck, but some judicious use of WD40 and a few days "rest" will generally free them for close inspection and cleaning. All the aluminium chassis sections unbolt and again got the dishwasher treatment.

The line-output transformer looked in a shocking state. They often do on these Bush sets, but that doesn't necessarily mean they are faulty. But the suspicious looking hump on the top of this specimen didn't look promising. Good job I had a spare.

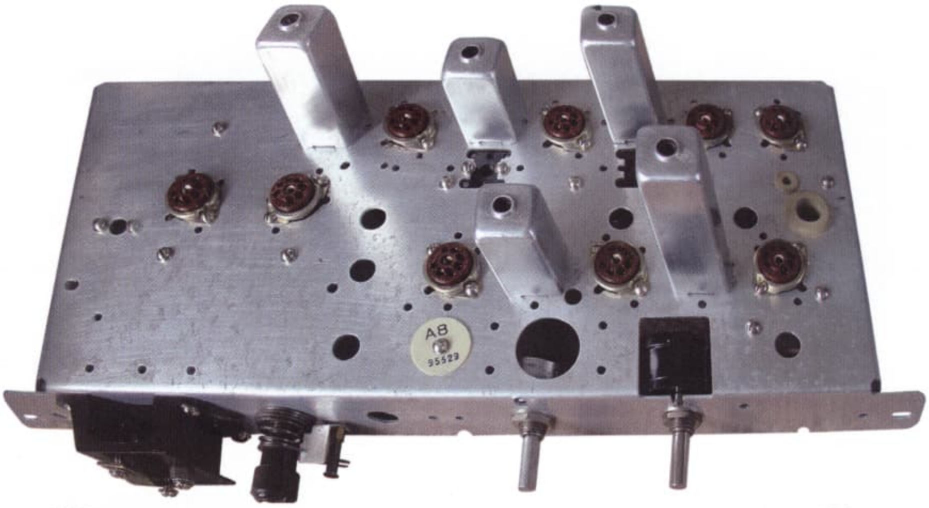
First switch-on

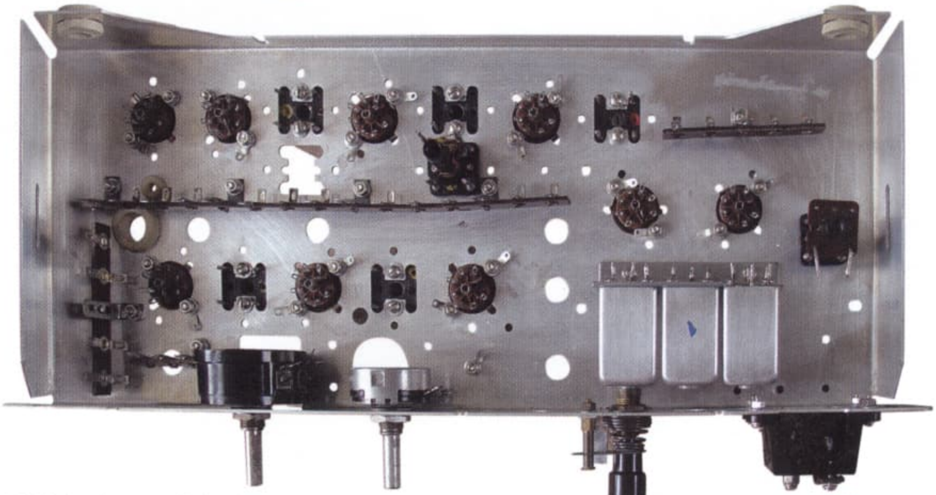
With all parts cleaned or replaced with new - where appropriate - it was time to carefully recheck all my wiring of both the main and RF chassis against the circuit diagram. I had to correct two errors.

Without fitting the tube, but keeping heater-chain continuity with a 22 ohm 4 watt resistor in its pace, I did some basic resistance checks before applying mains for the first time.

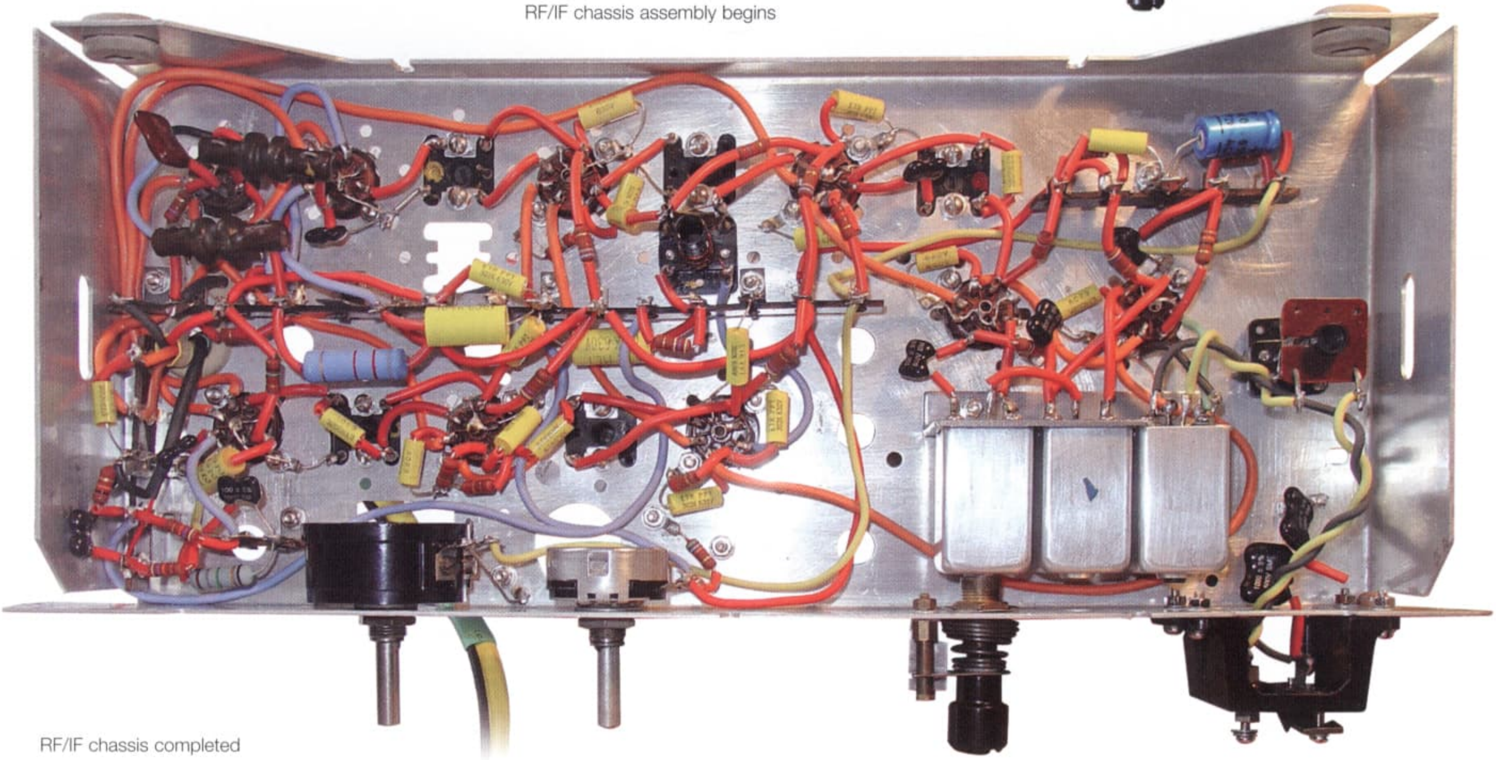
The heaters started glowing and the line whistle became audible and grew stronger. After a few minutes all seemed well with no fizzing, bangs or smoke! I checked most of the voltages and they were all more or less as shown in the service sheets.

Time to fit a tube. Of the four TV24s I'd acquired, it turns out only one of the tubes was fairly usable, one was barely usable, but the other two were useless. During this initial testing, it seemed prudent to use the worst of the two working tubes so that if disaster stuck while performing any

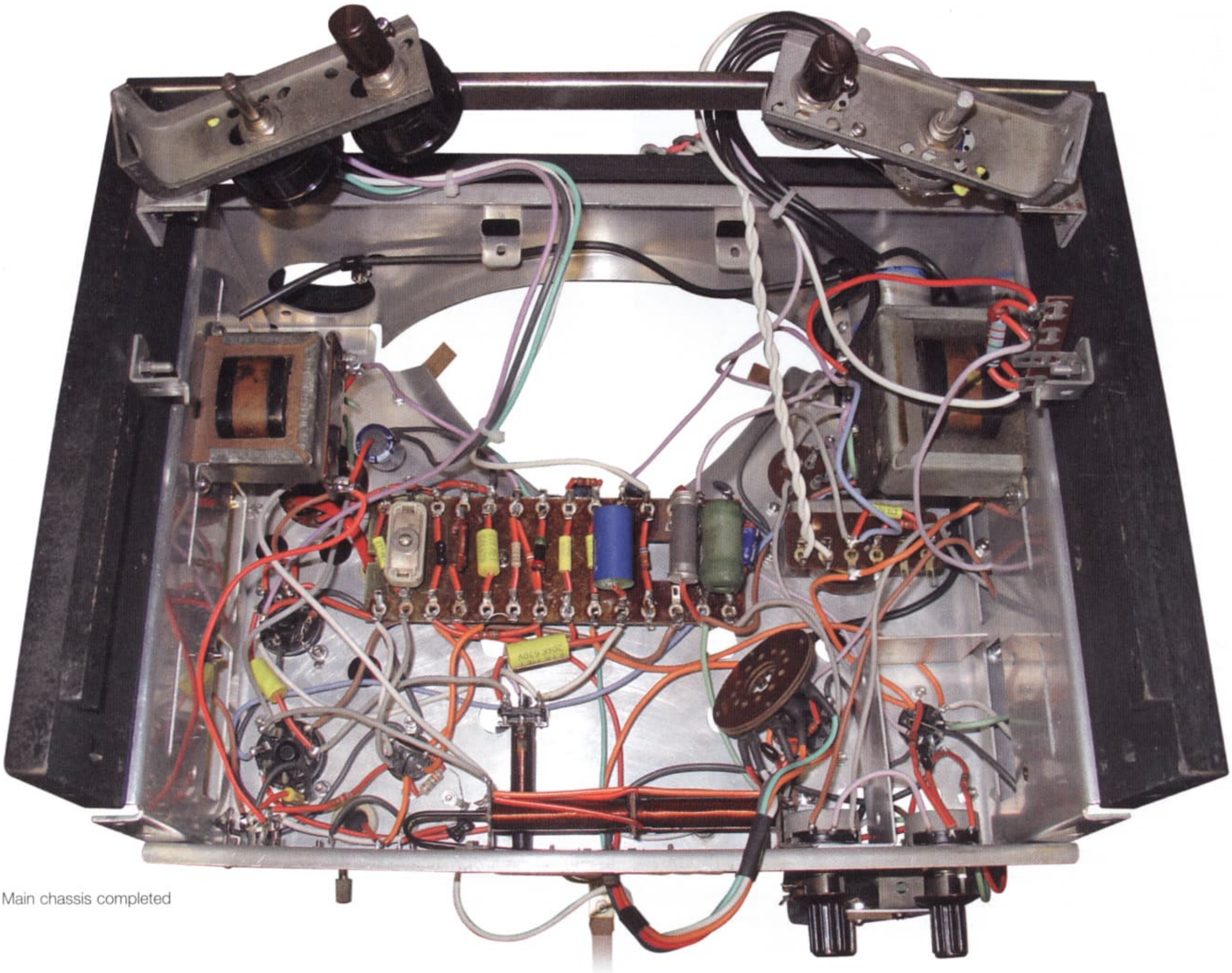




RF/IF chassis assembly begins

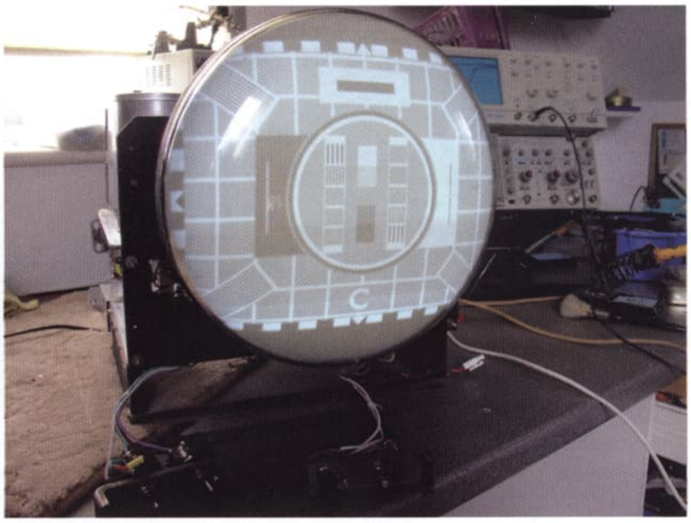


RF/IF chassis completed



Main chassis completed

Glass imperfections



Nearly there

unwieldy chassis handling, all was not lost.

With the Aurora standards converter now connected, I switched the mains back on. Heaters glowing, line whistle present and tone through the speaker, but no picture.

I gently eased the tube in and out of the focussing assembly while adjusting the ion-trap magnet. A weak off-centre raster momentarily flickered into view. With more wobbling and tweaking of the magnets I got the image roughly centralised, with the faintest signs of a test card amongst the tangled raster. Proof of nothing seriously wrong with my reassembled circuits. I reckon I'm nearly there so celebrate with a beer...

Real work begins

A few days later I decide to try to get this set working properly, assuming that since I'd rebuilt the RF/IF strip it probably just needed a slight tweak of the RF and IF cores, before attending to the picture centring and geometry.

The first problem was that the sound IF burst into occasional oscillation, and the picture lacked definition. After a day of head-scratching, measuring and tweaking I had a brainwave. I had another complete TV24 MK1 so I removed the RF/IF strip and just quickly replaced all the dodgy wax-paper capacitors and the one electrolytic and plugged it in to my rebuild. It worked perfectly; there were still some picture geometry issues to resolve, but it proved there was something definitely wrong with my conscientiously rebuilt RF/

A nasty lacquer run

All cleaned, repainted and polished

IF strip, which was pretty deflating.

I checked and rechecked my wiring, the components, valves and voltages. Everything seemed in order – it just didn't work properly.

Another brainwave; rig up a temporary LT/HT power supply and connect it to both RF/IF strips and do some proper signal tracing with my signal generator and oscilloscope. This proved inconclusive. The hastily lashed-up old one simply outperformed my rebuilt one.

Getting frustrated, I decided it was time to get to grips with my Heathkit HFW1 TV Alignment Generator – purchased years ago but never used.

That was a waste of time. It didn't give any meaningful trace on the 'scope. It didn't appear to be working properly, so the whole project went on hold for a few weeks...

Heathkit's errors

I was able to borrow another HFW1 and discovered that although mine was so well built it may have been one of those sold ready-assembled by Heathkit, it had been put together with a grid-coupling capacitor connected to the HT line so it never had worked!

Although the HFW1 can't be described as an item of precision lab test equipment, it did turn out to be very useful. Looking at the two RF/IF strips together with my now-fixed HFW1, it revealed that my rebuilt strip clearly had insufficient gain in the vision section, and the sound section was prone to instability. After again checking voltages and component values, it occurred to me that the instability may be due to the component positioning in the chassis.

I'd used smaller metallised polyester capacitors to replace the larger waxed-paper ones, and in just a couple of places I'd not used the same earthing points if there was now a nearer one and I could use shorter leads. Moving earthing points was a risk I took; it was a bad idea. I had now introduced some unwanted coupling or RF currents that were just sufficient to cause the sound IF circuit to oscillate at certain tuning settings.

With this fault now cleared there was still insufficient gain in the vision IF. No amount of tweaking following either the Bush, Trader service sheets or using the HFW1 corrected it. Comparing stage-by-stage signal tracing with the working strip didn't reveal much ether. All the vision stages on my rebuilt RF/IF strip appeared to have low gain.

Found it!

I decided to just check the vision IF cores once more... BINGO! One of the vision IF transformers contained three ferrite cores, one hidden in the centre

Working well

so it wasn't obvious when making upper and lower core adjustments. I'm not sure why this had such an apparent effect on all the vision stages, but once I removed the rogue ferrite, a few more minutes of tweaking with the HFW1 brought up the gain to slightly more than the old one I was using for comparison. So far so good.

Next to sort out the picture. Using the Aurora's Test Card C, I slightly tweaked the vision IFs for better definition, but this only provided minor improvement over what I'd already achieved. However, the test card was useful in adjusting some of the cores to minimise slight vision-on-sound buzz.

Width

The biggest problem now was the inability to get the picture wide enough to fill the mask. The width control was at maximum, but the width was still about an inch short of the edges.

I knew valves that tested "good" but when placed in the frame and line output stages sometimes gave significantly different performances in these sets, but on this occasion changing them didn't make much difference. Neither did repositioning the scan coils or focussing magnets.

Stumped, I posted a question on Paul Stenning's Vintage Radio Forum and the VRAT Forum. I got some good suggestions which I tried. They all changed the picture in one way or another, but didn't significantly increase the width.

The EHT seemed about right when measured with a probe, but I decided to see what happened if I played with the value of C31 (Trader Sheet 1003/T15). The Bush service sheets show it's 470pF on the TV22 and 300pF for the TUG24 and TV24.

I temporarily replaced C31 with a 1000pF high-voltage variable capacitor. With the capacitor fully open the picture was small but brighter. Fully closed it was dim, murky and started to "balloon", even after readjusting C25. There was no obvious "sweet spot" or resonance.

I had a spare line output transformer rewound by Mike Barker and as a last resort I installed that. It did the trick and easily provided the necessary width. I decided to check the "faulty" LOPT windings and the only significant difference I could find between it and the good one was that the inductance between the pins for the heater winding of the EY51 EHT rectifier was 44uH, 1.8 ohms. The other six I've measured over the years were between 12uH and 17uH, at around 1.4 ohms. A rogue one? A bad rewind? Who knows.

A rewound LOPT transformer with numerous tappings and windings is unlikely to have exactly the same characteristics as the original. My experiments with C31 found that about 500pF gave a good compromise between brightness and width with my particular rewound LOPT.

Speckles

While completing the final adjustments I noticed speckles and dots moving across the screen intermittently. It looked like arching somewhere, or a component starting to fail. Nothing untoward from the speaker, just the tone from the test card. Would this project never end…?

After a few minutes of watching it would come and go, I located the cause; it was interference from my fancy gel-cell battery charger!

I got a much better tube than either of those I already had, from Mike Barker. Once installed and all the magnets and electronic vision adjustments made, it gave a very good picture.

One mystery I did notice with this particular tube, but not the others, was that although this tube gave a brighter picture, with contrast set to normal, the picture could not be completely extinguished by turning down the brightness. Even with brightness set to minimum, the contrast could be set to give a very good picture – at least on the Aurora's test card. With real programmes of varying overall brightness, not having the full range of brightness adjustment might be a problem.

Voltage tests on this tube revealed that with a correctly set-up picture, the A2 grid voltage is about 10 volts rather than the 35 to 40 the other tubes gave. All other tube voltages were more or less as expected. I increased the tube cathode resistor from 220k ohm to 560k ohm and that gave the brightness control more range towards the lower end.

I spoke to an experienced restorer, Graham Gosling about it, and I think we concluded that it wasn't anything to worry about. Curious nevertheless.

Connections swap

To confirm everything was now working properly, and with the Aurora generating Test Card C, I connected its output to both my TV22 MKII and TV24 MK I, then moved them back to back and just swapped the tube-base connections over. (It is imperative that both chassis are connected to neutral before doing this!)

With a slight readjustment of the brightness on each set, this test was quite revealing. It clearly showed that the TV22 had a slightly wider vision bandwidth than the TV24 (something I'll have to address in future – it may be a minor TV24 IF alignment issue) but that the TV24 good tube was very good, despite the curious brightness anomaly.

Incidentally, these tubes occasionally have what appear to be a scary looking crack or chip in them. They are almost certainly neither, just minor defects in the tube manufacture. They fall outside the picture area behind the mask so are of no consequence. Nevertheless, in a close-up photograph they can look quite unsettling.

Nearly there

Of my four TV24s, only one had a decent cabinet, but it needed re-finishing, so I took it to a local furniture restorer. Cabinet restoration was not something I thought I could do myself.

The manager was interested in my project, and said they'd restored some odd things, including a wooden toilet seat, but not a 1950s TV cabinet. He assured me it would look like new, with the original two-tone veneers showing through.

A couple of weeks later I went to collect it. What had they done...? It was now almost mahogany coloured, with the two-tone veneers completely obscured. On questioning they replied: "Oh, yes, well, er... we did have to darken it a little." I assume they rubbed right through the veneer somewhere and could only cover that up by darkening it. What can you do? What's done is done – very expensively too! It wasn't until later I noticed a long run in the varnish/lacquer on the left side. This issue has yet to be resolved...

Finally I tidied up the paint in the knobs and Bush badge. The method I've developed is to pick out loose paint with a cocktail stick, soak the knob is soapy water for a few minutes and with a stiff brush (I use a toothbrush with the bristles cut down to about 2 to 3mm) rub out the rest of the old paint. Dry the knobs, then with the paint of your choice (I use those little touch-up pots for cars), dab it across the embossed lettering and firmly smudge it in with a finger.

Once dry, rub off the excess with a tissue dampened in nail-varnish remover (acetone) or the appropriate solvent for the paint you've used. Repeat if necessary and buff with wax polish.

Enough

After a project that took about a year, I hope this rebuild will be trouble-free for the foreseeable future, although I'll always be on the lookout for spare 9 inch or 12 inch tubes – just in case. Despite one of the problems being of my own making, I am confident that I can probably tackle a Bush TV22/24 regardless of condition. But to be honest I think I've had enough of them…

Philosophies of restoration

This subject could support a whole article in itself - and perhaps has done. There are a range of options from doing nothing and leaving the set in the condition in which it was found (useful for future generations to examine the original materials, construction methods and components of the period), to stripping down and reassembling it with "unnecessary" new components into what some may describe as a modern reproduction!

Years ago my approach used to be about midway, i.e. to replace all the components known to be or likely to become faulty (i.e. wax paper, Hunts and some electrolytic capacitors), to change resistors only if they had become noisy or drifted upwards in value by more than about 25 percent and to replace any wire suffering from perished insulation.

It's irrational, but this left me frustrated as I couldn't clean the chassis properly, to get into all those grubby nooks and crannies. I cleaned tag strips, valve holders, etc. sufficiently to remove any possible high-resistance tracking after decades of these sets living in coal-fired, smoky rooms (which can lead to difficult-to-trace faults) and operation was always fully restored. Nevertheless I still felt the job was only half done. (In one case it truly was only half done. I'd missed a hidden trapped wire with perishing insulation that caused intermittent crackling in BC348 communications receiver which took weeks to track down!)

Then I acquired an old Heathkit DX40 transmitter that needed some serious TLC. It had undergone a number of poorly-executed modifications, and seemed to have suffered a small fire! Patching up would have been pointless, so I set about stripping it down, thoroughly cleaning all mechanical parts and rebuilding with many new components. This proved a turning point for me; it had been a thorough process from beginning to end, enjoyable to implement and satisfying to now own something that looked like new and worked absolutely as specified.

I now use this meticulous approach on most of my restorations. I don't make any circuit alterations unless there is a good safety reason, or a potential fault that has been identified and corrected by a service bulletin.

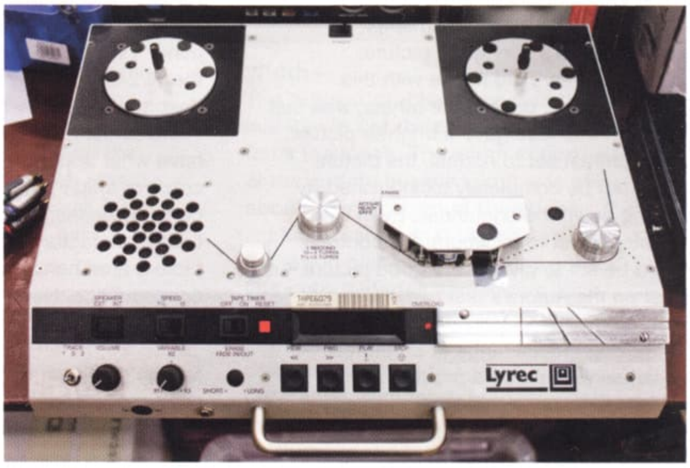
But as described in this article, this approach has on more than one occasion lead me into traps of my own making that have sometimes been time consuming and frustrating to rectify.

I appreciate that some may consider my method to be excessive and generally unnecessary, and it would surely be inappropriate to do this to a rare or valuable radio or TV – none of which I own anyway! I also realise that a set 60 or 70 years old shouldn't necessarily "look like new". But I don't want to gaze at something with a flaking dial or disintegrating speaker cloth, even if it works properly!

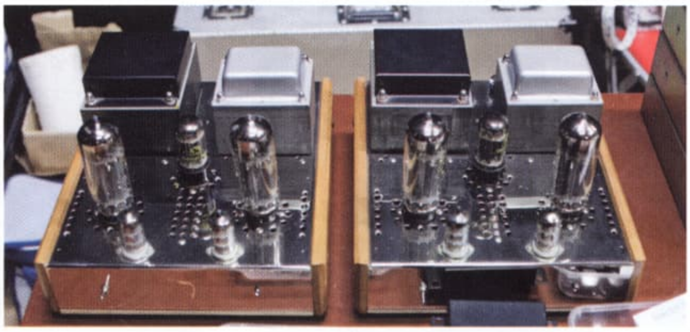
Nevertheless, after my work I am rewarded with sets that are hopefully completely reliable, are unlikely to develop obscure, intermittent faults, and function and look as well as the day they left the factory.

Spring Audiojumble

Photographed by Carl Glover

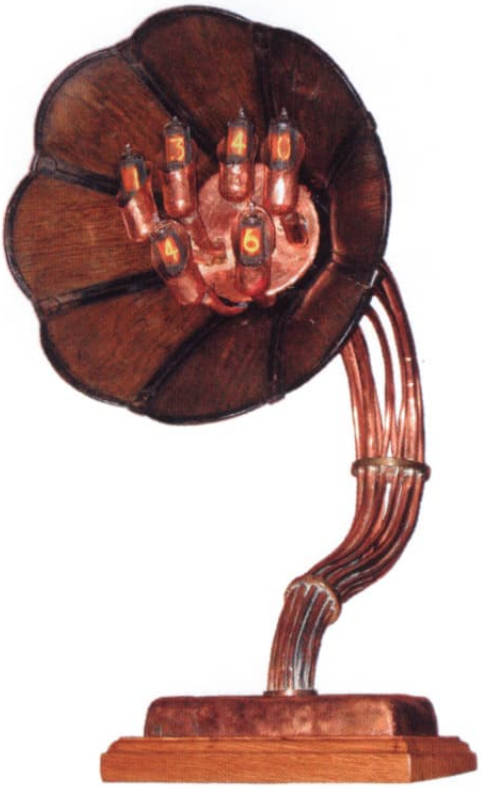


Acoustical Type MB PA amplifier, 1949



A dragon of a Nixie by Mark R James

Like many projects this one evolved from unplanned opportunities. At one of the auctions I spotted some Hivac XN11 Nixie tubes in the bottom of a box of valves. These rekindled memories of school physics labs etc. I was unsuccessful in my bidding but the buyer, who was unaware of the Nixies in the box, kindly sold them to me.



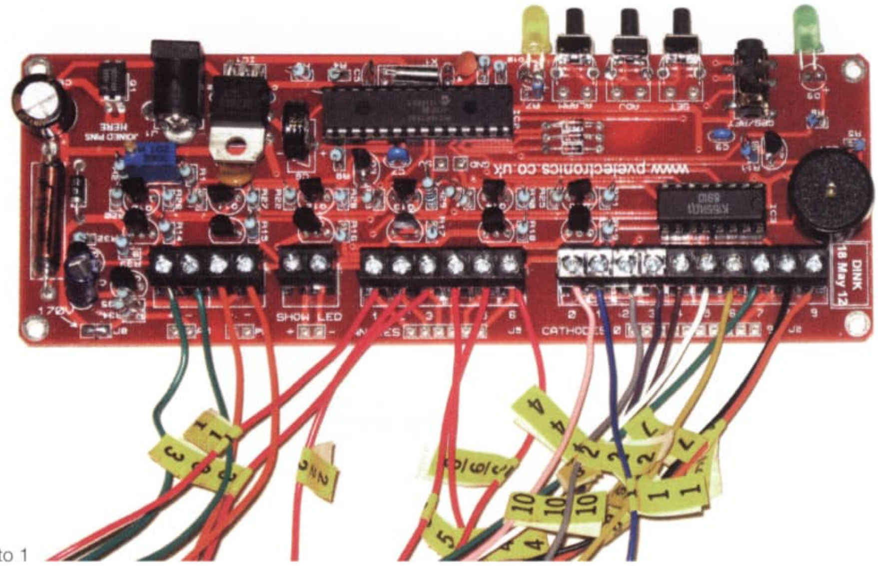


Photo 1

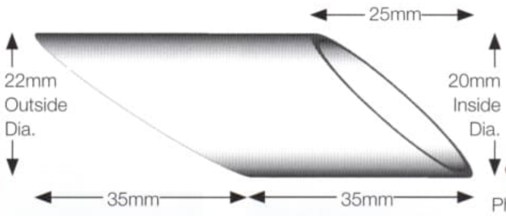


Photo 3

Photo 2

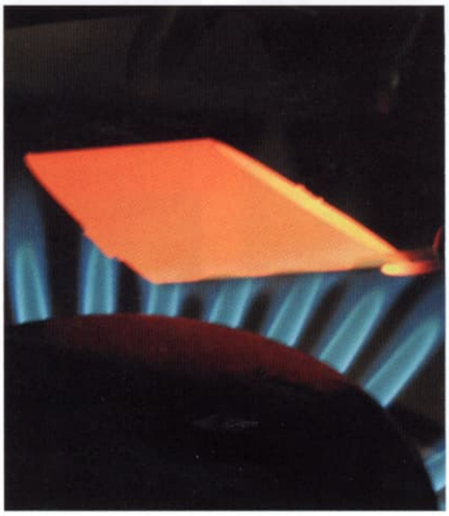


Photo 4

Photo 5, 6, 7

I knew nothing about this technology so there followed some online research the result of which was the decision to build a clock as it would show them to best advantage. I decided to take the easy option and bought a circuit board and components from PV Electronics (ref 1). The board and instructions were of the highest standard and should pose no problems for an able teenager with some supervision. There are 66 wires leaving the Nixie tubes so colour coded wiring and labelling is strongly recommended. The circuit uses a multiplexing system so reducing the actual number of connections to the board – all explained in the instructions (Photo 1). The refresh rate is 600Hz so no worries about visible flicker.

The next design question was what housing to use. This was fortuitously answered at a subsequent auction where a small (10" diameter) oak Amplion horn minus the rest of its structure was for sale (Photo 2). The idea was born and the horn successfully bid for. The construction of the stand is more straightforward than it looks and should not be beyond the capabilities of most vintage radio restorers. All the copperwork is offcuts of heating and other pipe from the scrapbox. Nothing was purchased! The key to the construction is the properties of the copper. Iron and steel have to be worked/formed while red hot. Copper, however, can be annealed by heating to cherry red and then quenching in water. This softens it so that it works like red hot iron. However, as it is worked it hardens and then requires re-annealing before further working. If overworked it will crack. While in its soft state it can easily be hammered into a new shape. After a couple of tries it was found that the cups for the tubes could be formed from a piece of copper tube cut as in Diagram 1 & Photo 3. This is annealed (Photo 4). I used the cooker's gas hob for this. If, like me, one has been previously caught smelting lead on the hob and heat treating steel on the "Pyro" setting of the oven then annealing copper is regarded as a minor misdemeanour hardly worthy of comment! The shape/size of the cups is determined by the Nixie tubes available. My Hivac XN11 tubes had flying leads. I soldered extension leads to these and insulated the joins with heat shrink tubing. The base of the cup could be sized/shaped to accommodate a valve holder provided the connections were appropriately insulated. This would make changing the tubes immensely easier. The cup is quite easily formed using a small ballpein hammer, a vice, a flat chunk of steel to use as an anvil and a simple former. The former is a piece of 18mm diameter steel with a round end (Photo 5). I actually turned mine in the lathe from hexagon stock but it could easily be filed/angle ground by hand. The lip of the cup is formed by hammering the long edge of the bevelled pipe to thin and expand it which automatically forms the lovely 3D curve. No cutting off or filing is required. The lower end is then worked over the former leaving a hole at the back for the wires. Again no metal removal is necessary but repeated annealing is (Photos 6-8). It does not take long - I made two experimental cups to get the pattern correct and then 8 actual cups in a morning. I used the 6 best matching cups in the project. The stems for the cups are made from 8mm diameter copper tube. One end is flared as one would do for a brake pipe, it is then bent to shape and passed through the cup from the top opening and soldered in place (Photos 9 & 10). The six cups on stalks were then fitted and soldered to the back plate (Photo 11).

The remainder of the stand is straightforward to construct (Photo 12). A full size lateral view of the horn and stand was drawn and adjusted until the curves looked right and the estimated centre of gravity was over the base itself. The cylindrical attachment to the horn was formed from a piece of 75mm diameter copper tube using the same processes as above. The key to constructing the framework is to bend all the tubes to shape against the side view drawing before assembling them. Drilled discs of brass were made for 3 levels plus the top to space the tubes and hold them in place. Once soldered it forms a very rigid structure. A lighter fuel powered micro-torch is quite adequate as a heat source for soldering. I had no copper sheet to make the base which houses the circuit board so opened out a piece of copper tube and hammered this to shape over a wooden former, again with regular annealing. The circuit board was mounted inside the base which was then put on an oak plinth to aesthetically balance the oak horn petals. By luck/planning the centre of gravity was almost exactly over the centre of the base which I loaded with plumbers solder and a ¼" brass plate (also from the scrap box) to add some weight (Photos 13 & 14). A heavier duty gas torch is required for annealing the base and loading it with solder etc. Obviously all the wiring is concealed by running it inside the tubes from the Nixies in the horn to the circuit board in the base. After the wires have been run the tubes were "distressed" to give them an older appearance and blend with the whole structure. The shiny, new, uniform copper pipe did not look right. (I actually did this before assembling and running the wires – a bit of a gamble that I got away with this time! The wires were tight to run in places and I was concerned that the insulation may have been damaged so before connecting the circuit board I checked for any shorts between any wire and the casing and to each other.) I am extremely pleased with the finished result which goes very well with the other "artefacts" around the house and utilises components regarded by most people as having little value.

For those who want a quicker project the cups could be formed with the outlet hole at the bottom rather than the back of the base and a vertical tube attached to form a stem. A bunch of 6 "Lilies" could then be put together to stand in a weighted vase. The wires would run down the stems to the circuit board concealed in a supporting plinth. I await your photos!

Ref 1. www.pvelectronics.co.uk
The circuit board used was DINK which easily allows remote wiring of tubes as in this project. I have no connection to the company apart from as a satisfied customer.


Photo 8


Photo 9


Photo 10


Photo 11


Photo 12

Photo 13

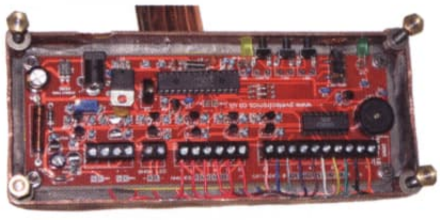



Photo 14


Photo 15

Automatic Frequency Control

A short review and a retro fit project for an R1155 by Roger Grant

This project started out as a feasibility study to see how I might fit electronic automatic frequency control to my R1155. This is my workshop set where there are large variations in the ambient temperature, due to this the set had suffered from severe and very annoying tuning drift, made worse by myself moving the Medium wave band up 100kc/s to cover 1600kc/s. I got over the problem with a simple mechanical temperature compensating device (see Bulletin Winter 2014) that did the job well, but I thought an electronic AFC would make a better job of it and a very interesting project at the same time, and I wasn't wrong.

The finished R1155

Starting at the very beginning, a recap of the problem and what's required to fix it. With the coming of the superhet receiver where the sets tuning is determined by the single control of a local oscillator, an inherent problem of tuning drift due to oscillator drift came with it, this is usually due to changes in temperature or humidity. This was not so obvious a case in the earlier TRF sets with multiple tuned circuits with a much wider band width. Most domestic sets would live in the home where the temperature would remain reasonably constant and the problem go unnoticed, just requiring an occasional tweak. The big British manufacturers seemed to consider AFC only required with pre-set or motor tuned sets where the mechanics don't hit the exact spot every time, or in VHF sets where the tuning is much more critical and needing some form of automatic tuning correction.

Due to their high gain, superhets were designed with an Automatic Volume Control (or Automatic Gain Control) out of necessity, the circuitry for which only requires a few passive components and can be built into the amplifier circuits design at very little extra cost, but AFC where detection and control are required, usually needs two expensive extra valve stages, so these techniques were reserved just for the up-market range of sets, and a good reason why you don't come across AFC very often.

The first problem is detecting the tuning error. When the local oscillator is slightly off tune, so is the IF frequency and a lot of early designs used dual tuning circuits to detect this, one tuned just above the IF frequency and one just below, the rectified output voltages were connected in series and in opposition so when the set was in tune the outputs were equal and opposite and cancel each other and no control voltage produced, when the set was slightly off tune one of the tuned circuits will produce a greater signal than the other and a control voltage will be produced proportional to the mis-tune with the polarity depending

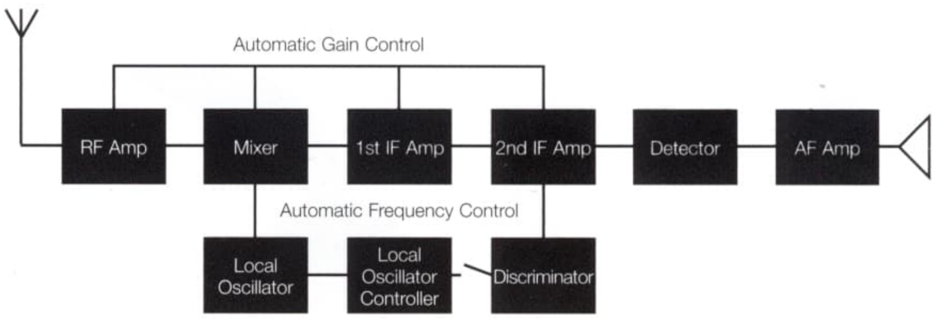


Fig 1: Block diagram of a Superhet with AFC

SERVICING AUTO TUNING SETS

6—Automatic Frequency Control

Principles and adjustment of the A.F.C. circuits used in some motor-tuned receivers are dealt with in this the concluding article of a practical series on all automatic tuning systems.

EVERY system of press-button operation involves the setting of a variable capacity or inductance at a predetermined point. This may be the mechanical setting of a variable condenser or the selection of a pre-set condenser or inductance. Owing to temperature changes, humidity and other effects, the electrical constants of the selected or adjusted condenser or inductance may vary. Apart from this, variation in the generation frequency of the oscillator valve tends to occur with time and also with temperature. There is, in fact, an initial period after switching on a valve during which the frequency changes at a fairly rapid rate. There is always a slight drift going on, and this may be "positive" or "negative."

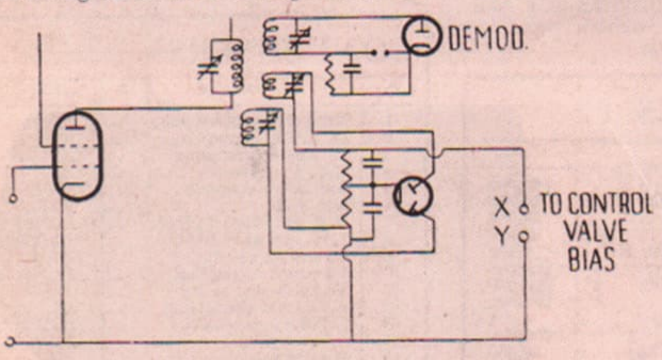
In the more expensive automatic receivers, and particularly those with motor drive, some form of frequency control, usually abbreviated to A.F.C., is employed. This is brought about by a separate control valve and a special circuit which is usually associated with the second I.F. transformer.

The manner in which it functions will best be understood by considering what happens when the oscillator valve drifts from the correct setting. The frequency of the received signal can be assumed to remain constant. The correct setting of the receiver for this particular station is such that the difference between the received frequency and the locally generated frequency is equal to the intermediate frequency.

Tuned to Side-bands

If the oscillator valve drifts, the intermediate frequency becomes incorrect. The intermediate frequency signal tends to occur where the side-bands would be normally. If, therefore, the second I.F. transformer, for example, had a circuit sharply tuned to a frequency representative of the extreme side-band on one side or the other, an appreciable voltage would be developed across the circuit. If the circuit were connected to a rectifier and load, a D.C. voltage would be produced across the load.

What is actually done is to provide a circuit on the lines of Fig. 1. It consists of two circuits, one tuned slightly (say, 5 kc.) above the correct intermediate frequency, and the other slightly below. Each circuit is connected to one of the diodes of a double diode and each has its own load resistor.



Tuning error causes shift of the I.F. "Dis riminator" circuits tuned above and below I.F. (Fig 1, left) and connected to a double diode, produce positive or negative voltages across x and y.

What happens when the correct I.F. occurs in the primary of the transformer? Each of the two "discriminator" circuits gives a voltage, dependent on the sharpness of the tuning, and if the input is exactly between them, the voltages will be equal. It will be observed, however, that the two diode loads are, in effect, connected in opposition, and as a result the voltage across the points X, Y remains constant.

If the injected frequency changes to 5 kc. above correct, one circuit might produce 6 volts and the other 1 volt. As a result there would be a difference of 5 volts developed across X and Y. Similarly, if a lower I.F. were introduced, the other circuit would produce 6 volts and the first circuit would produce 1 volt and again we should have a 5 volts difference—but in this case the D.C. polarity would be reversed.

This arrangement, therefore, provides a simple means of obtaining a voltage which is either positive or negative with respect to an earth line dependent upon whether an increase or a decrease in the intermediate frequency has occurred.

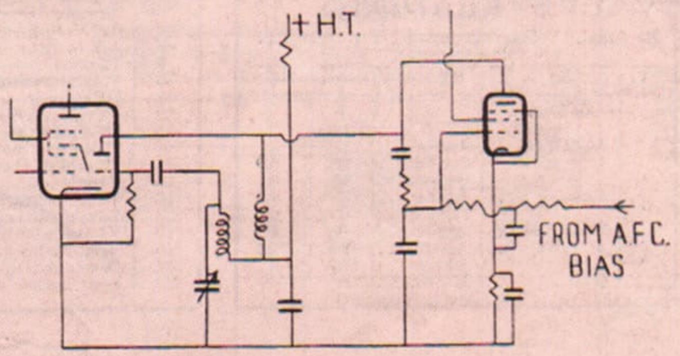
The next part of the problem is to use this variable voltage of either polarity to bring about a change in the oscillator frequency so that the correct intermediate frequency is once again produced. This can be done by associating the oscillator with what is known as a control valve.

The frequency of generation of an oscillator valve is dependent upon the inductance and the capacity of the tuned circuit, and to alter the oscillator frequency all we need do is to increase or decrease either the inductance or capacity. This is the function of the control valve. Many different systems of achieving control are available.

Miller Effect

One of the simplest forms of control is that of utilising what is known as the Miller effect, in which the "reflected" capacity of the control valve is used to vary the oscillator frequency through alteration of the conductance of the valve. This alteration of conductance is achieved by altering the grid bias or, in the case of a screen-grid valve, the voltage applied to the suppressor grid. Bias is obtained in practice from the control circuit shown in Fig. 1.

There are, however, certain practical difficulties in the use of this scheme, and it is more general to employ inductance variation. In the practical arrangement shown in Fig. 2 the oscillator voltage is actually applied to the anode of the control valve and a 90-degree out-of-phase voltage applied to the grid of the control valve. With this system of connection the anode current is of the same phase as it would be if the whole combination were considered as an inductance—the value of which depends upon the control voltage on the grid. As the grid bias is increased the effective inductance decreases.



Voltages from x, y (Fig. 1) alter the bias of a control valve (Fig. 2, right). This varies the conductance of the valve and the capacity reflected back to the oscillator tuned circuit.

Unless the various constants are correct the whole circuit fails to function, as can readily be seen. At the same time, the arrangement is not too tricky, and it is a comparatively simple matter, particularly after a little experience, to adjust an automatic frequency control circuit. Most manufacturers issue special instructions for carrying out these adjustments, but if such are not available, the control circuits can be adjusted from first principles.

First of all, it will be remembered that the discriminator circuit is the first link in the chain, and, accordingly, this must be inspected before anything else. Here we are likely to find two circuits tuned to

(Continued on page viii.)

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Automatic Frequency Control

(*Continued from page v.*)
so-many kilocycles above and below the intermediate frequency. To adjust these the oscillator should be connected to the intermediate valve grid and a fairly heavy signal rejected. At the correct intermediate frequency the primary and ordinary secondary windings are properly adjusted, and no control voltage should then be developed across the discriminator output.

A valve voltmeter is a convenient device for determining the presence or otherwise of this voltage, but if one is not available an ordinary high-gain valve arrangement can be used, the grid and cathode being connected across the test point and a sensitive milliameter included in the anode circuit, thus reading any change in current due to grid voltage variation.

An alternative method is to place a milliameter in the anode circuit of the control valve. It is important to stop the oscillator valve functioning during this test. Change of grid bias on the control valve must change the anode current, and, therefore, when the discriminator circuits are accurately adjusted and the correct intermediate frequency injected no anode current changes occur.

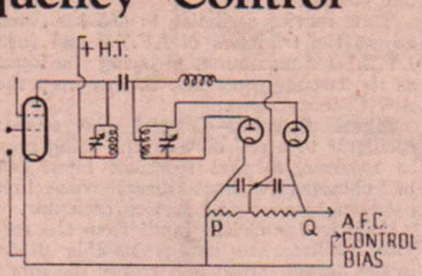


Fig. 3.—A discriminator circuit which operates by phase differences produced when the I.F. is off tune.

Next, it is important to know to what frequencies the discriminator circuits should be tuned. These may be something of the order of 4 to 5 kilocycles above and below the correct frequency. The higher intermediate frequency is injected and the appropriate discriminator trimmer adjusted for maximum output. The lower intermediate frequency is then injected and the other circuit adjusted in the same manner. The measuring devices described above can be used for these adjustments.

If control is now failing to take place, the trouble must lie in the control valve or part of its circuit. The decoupling network is usually very simple, and the condensers and resistances can be checked up in the ordinary manner.

Change in the anode current of the control valve shows whether this valve is functioning properly. If changes are occurring, the control effect must take place unless there is some break in the connection between the control valve and the oscillator circuit. Finally, it must be remembered that any trouble in the decoupling circuit will completely spoil the proper functioning of this control.

The circuits shown are typical, in particular the use of a single discriminator circuit of the type shown in Fig. 3. This arrangement generally utilises a double-diode valve with separate cathodes, and the increased voltage with respect to the centre tap across two diode loads occurs at frequencies off resonance due to phase changes.

In a circuit of this type the correct intermediate frequency is injected in the grid circuit of the I.F. valve, and the discriminator secondary circuit is adjusted until the output across the control points P, Q is zero. This voltage can again be determined by noticing the anode current change in the control valve or by the use of a separate valve voltmeter.

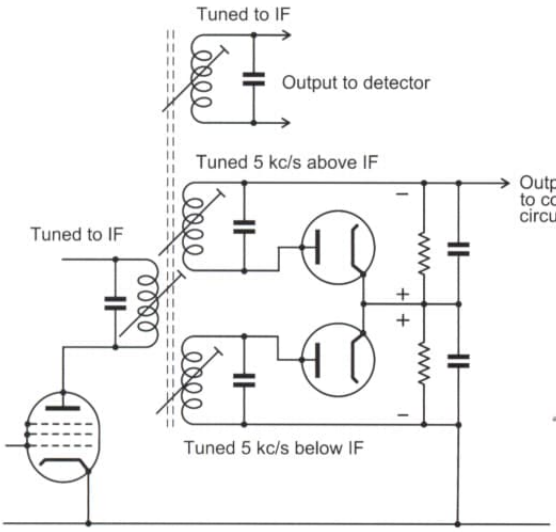
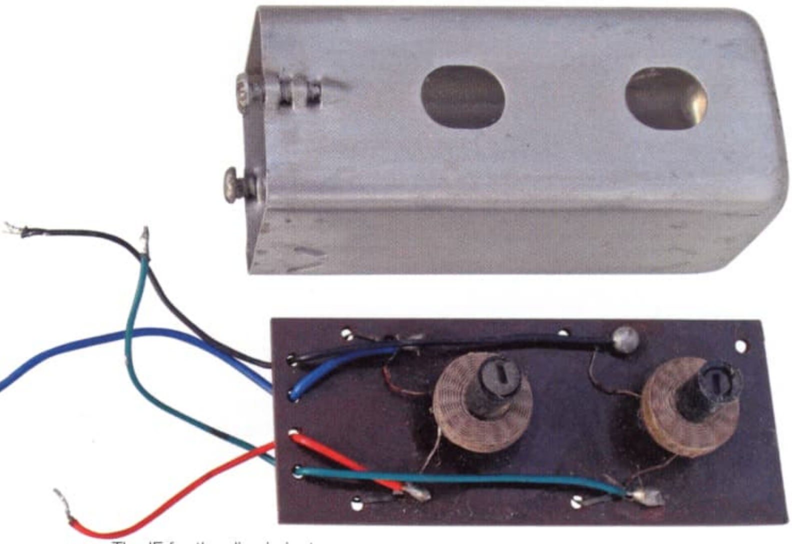


Fig 2: Double-tuned discriminator



The IF for the discriminator

on the mistune being above or below the true IF frequency, this DC control voltage is decoupled and passed to a local oscillator control circuit. The controller circuit sets the scaling of the control voltage and converts it into an inductance or capacitance to adjust the frequency of the local oscillator, bringing the set back in tune.

A search of my reference manuals and of the internet produced several articles and extracts, from generalised descriptions to some quite in depth reviews, (see ref 1). I also found some very informative articles in the Broadcaster sheets supplements of 1938, "Servicing Auto Tuning Sets" Part 6 (ref 3) and "Frequency Control in Automatic Receivers" (ref 4). There were quite a lot of American designs, AFC appeared to be a lot more popular in the States, I found these much more varied and diverse but I decided to concentrate on the British sets where I had full circuit diagrams complete with circuit descriptions and setting up procedures. They all appeared to follow the same basic format (fig1) and covered most of the main circuit techniques I was looking for to complete my project.

From here the next step was an in depth look at how the big manufacturers solved this problem as I didn't want to re-invent the wheel. I sifted through the "Trader" and "Broadcaster" sheets for a

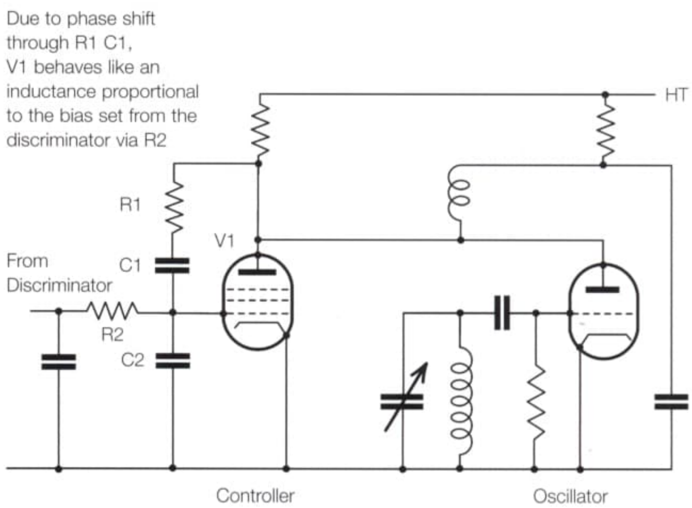
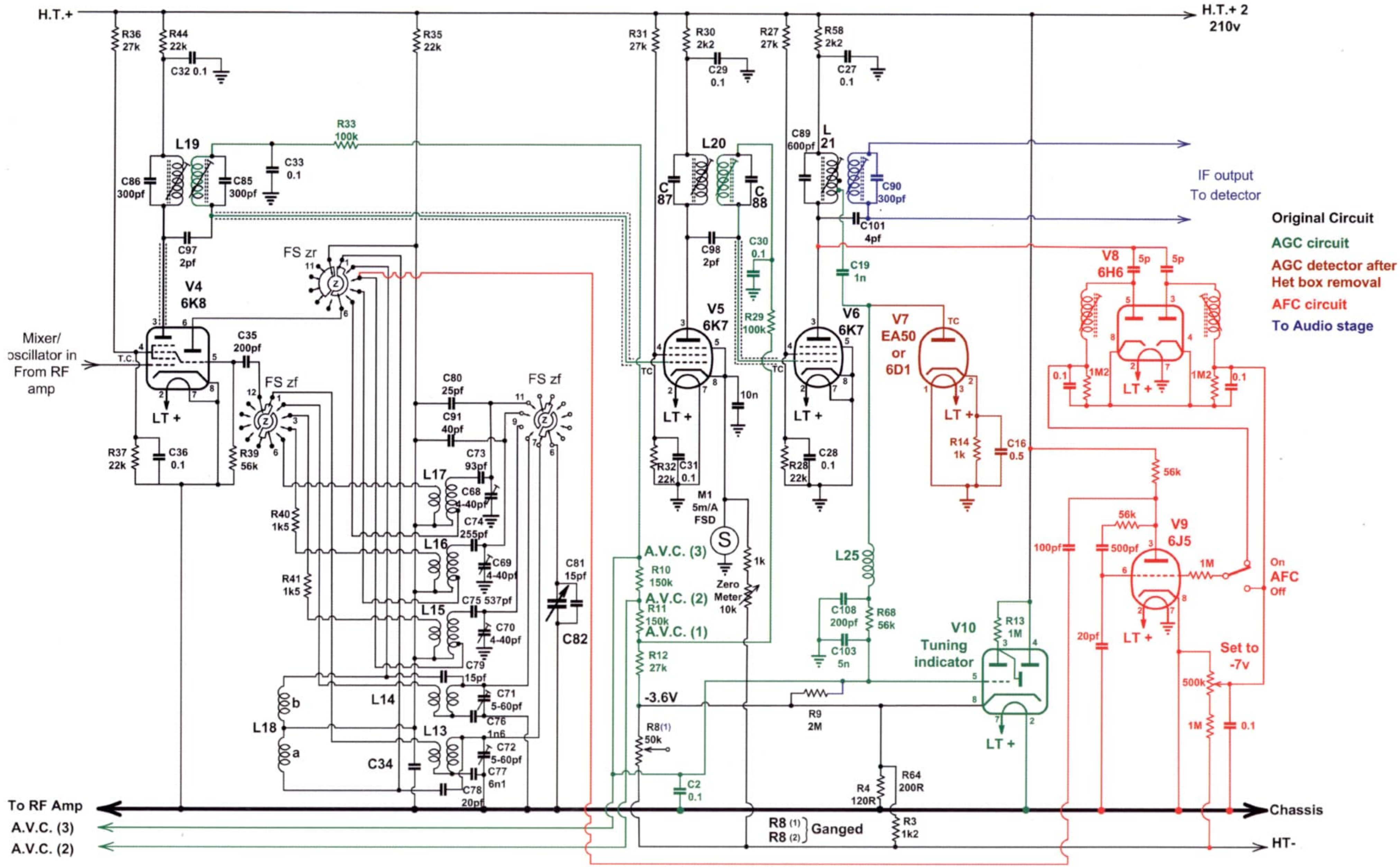
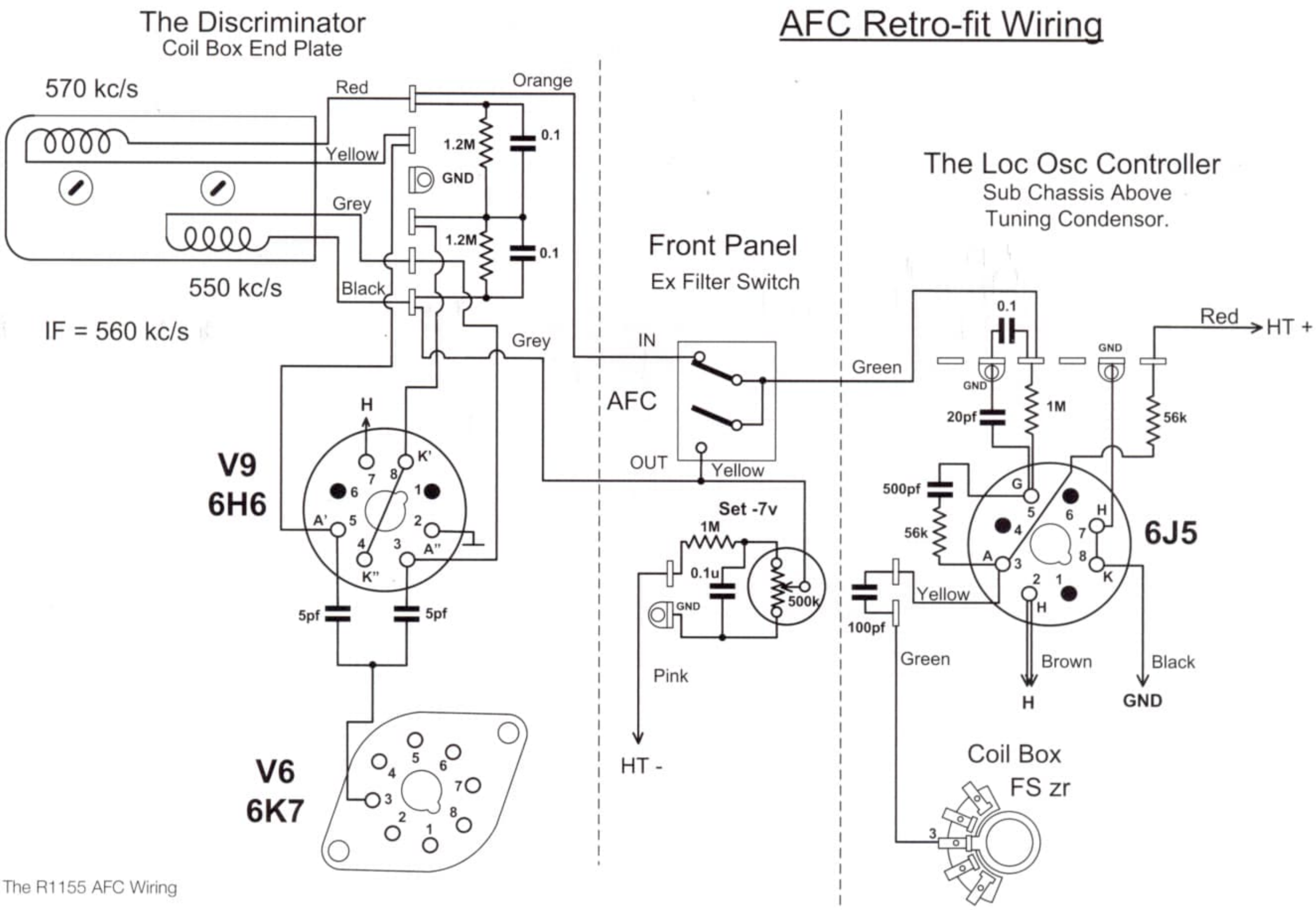


Fig 3: Reactance Controller

R1155 AFC Mod

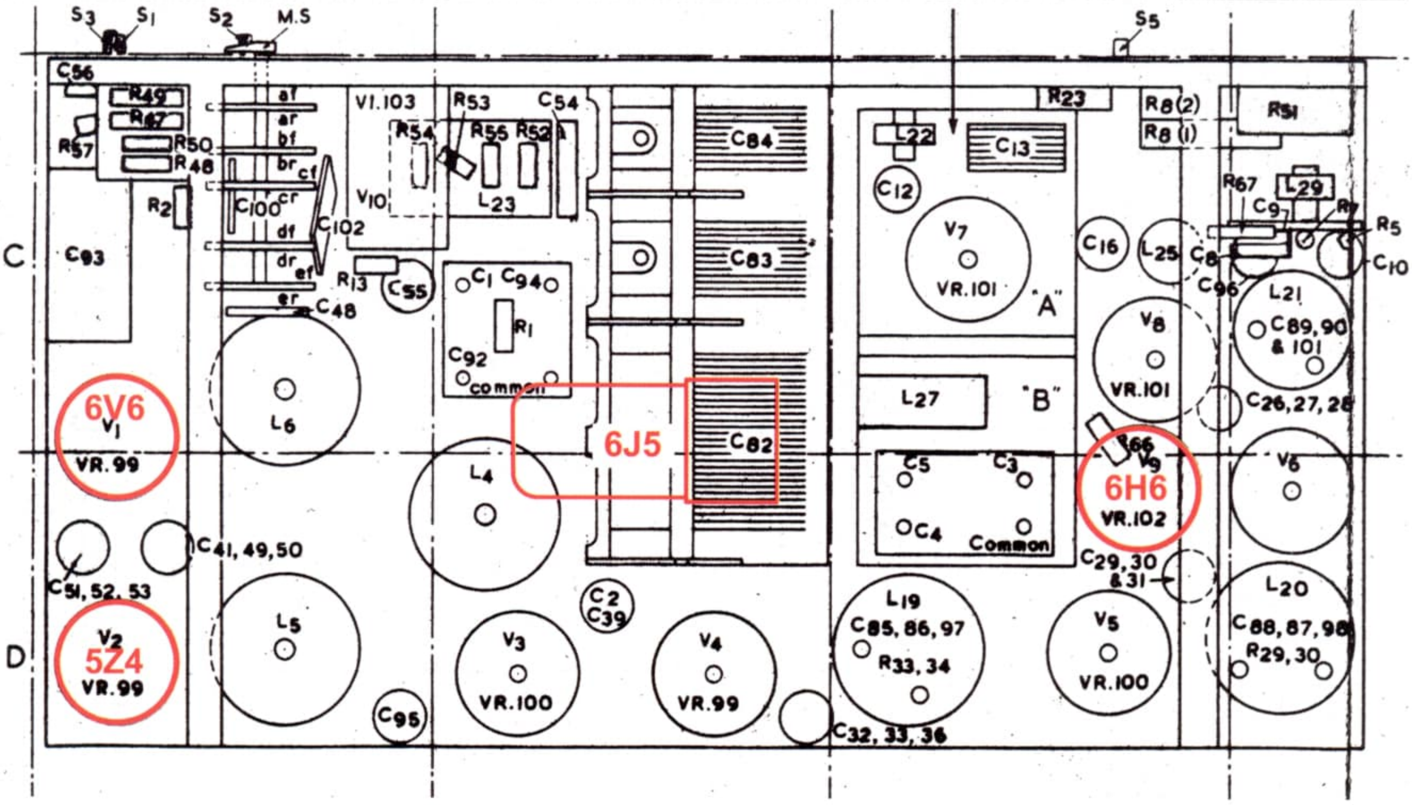




The R1155 AFC Wiring

good selection of different methods and only found a relatively small number of examples, most of which used inductive coupling and especially wound oscillator and IF coils, this would make modifying an existing set very difficult and cribbing someone else's design out of the question, but a good way of really getting to know all about AFC. I was looking to finish the project with a circuit that uses the same series of valves as the R1155 and could more or less fit into any similar AM valve set.

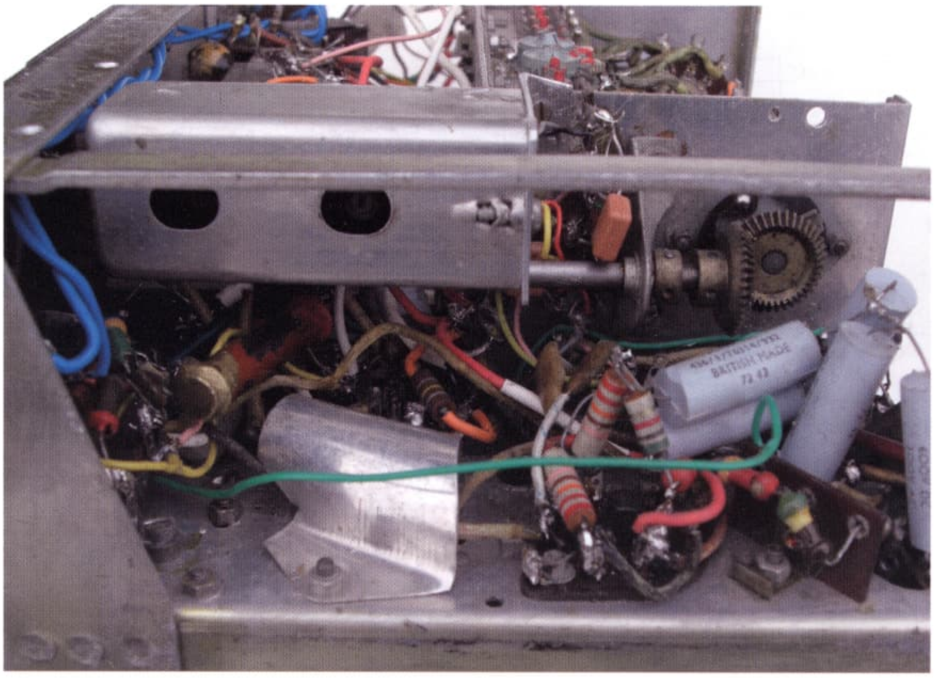
To make circuit diagrams clearer and for ease of fault finding, I usually insert component values and valve pin numbers, for the purpose of this article I've overdrawn the selected circuit diagrams in colour, Black the main circuit, Red the AFC, Green the



The R1155 AFC component location

AGC and Blue for the Audio stages, this makes it very easy to see what is doing what. I made a selection of five sets that covers most of the techniques required for my project. Starting with detecting the error, I found three main designs for this detector, referred to as the discriminator, the simplest was to use two tuned circuits as previously described, two extra windings on the final IF transformer rectified by two diodes (fig 2), some sets use two series tuned circuits as in the Murphy A28C (fig 7), these are capacitively coupled to the IF amplifier, this may be the route to take for a retro fit circuit. The most common designs use a Foster Seeley style of discriminator or one of its variants (fig 4a), as in the Ekco PB 189 (fig 5) this only requires one extra winding on the IF transformer but usually centre tapped, this centre tapped winding is fed with a capacitively coupled IF signal, the discriminator now inductively and capacitively coupled uses the ninety degree lead-lag phase shift relationship between C and L and produces an output as the frequency changes with respect to the tuned inductance, hence the resultant phase shifts, in this split winding one half more in phase with the capacitively fed signal and producing a larger combined signal than the other half less in phase and a lesser signal, and so the rectified DC output (fig 4b).

This DC control voltage is passed on to the controller, one of the most popular of the British designs of controller uses a DC amplifier and applies a DC voltage to an extra winding on the local oscillator coil, varying its inductance as in the Ekco PB189 (fig 5) or the Marconi 874 (fig 6). There are several versions of directly coupled controllers using a reaction valve circuit (fig 3). where capacitive feedback from anode to the grid makes the anode of the valve appear as



The discriminator fitted

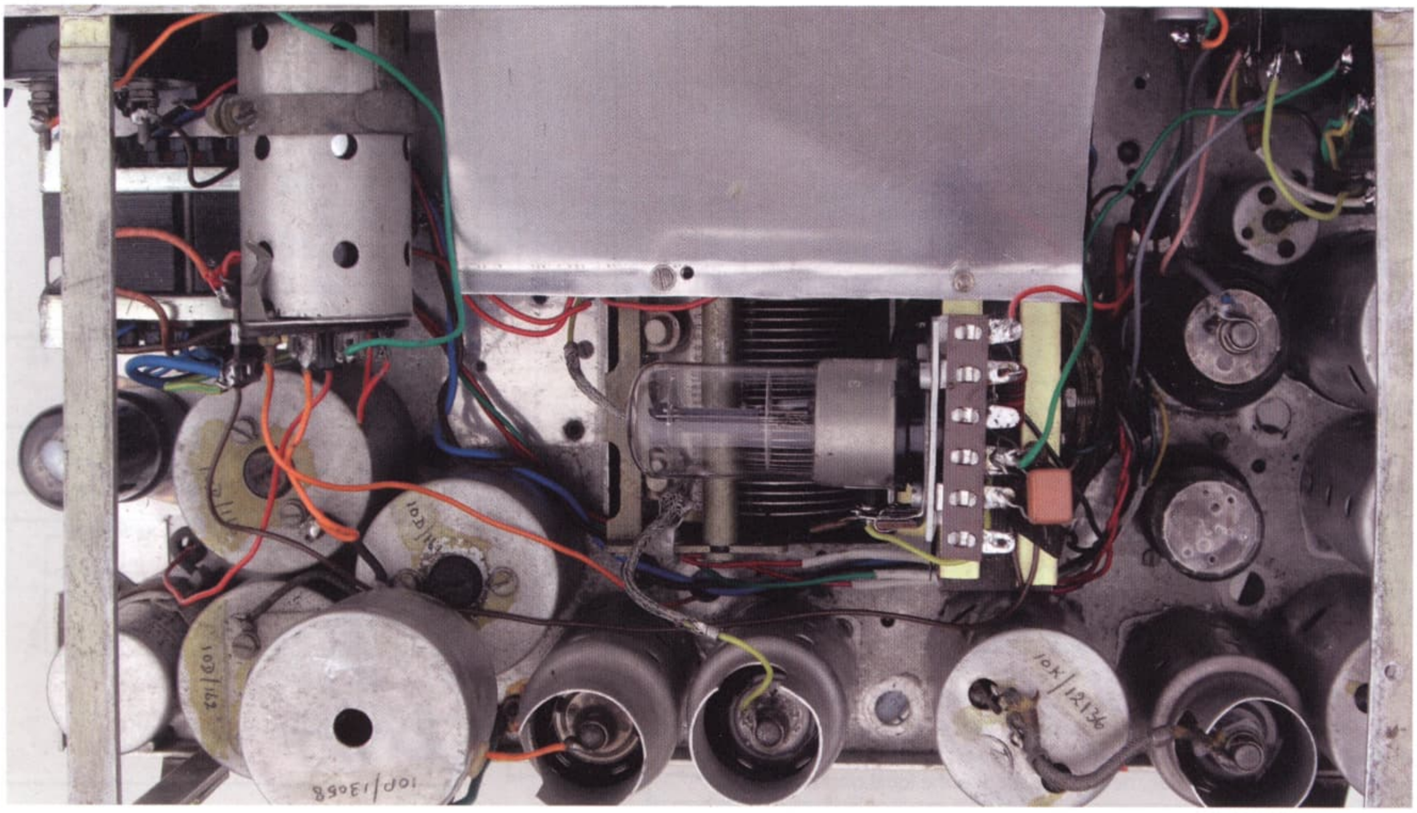
a low value inductor, this is referred to as a reactance or inverted Miller effect as in the Murphy A28C (fig 7), the McMichael 382 (fig 8) or the RGD Model 1015 (fig 9).

A rarer design uses the Miller effect of a pentode valve where the gain of the valve is controlled by the suppressor grid, this changes the internal capacity of the valve and this now variable internal capacity between the cathode and control grid is used to adjust the local oscillator (fig 10). I came across a generalised circuit description of this circuit technique in one of my reference books (ref 2), which would suit my project exactly but I failed to find a practical example.

Having now made a reasonable study of how it works and how the big boys resolved the problem, I was ready to select from these five examples the circuits for my project.

The Ekco PB189 (fig 5) uses the basic inductively coupled convention, V4 a 2D41 double diode as a Foster Seeley discriminator feeding V2 a T41 triode as a scaler and DC amplifier, this driving an extra control winding on the local oscillator coil. In this set the discriminator and controller of the AFC circuit are both inductively coupled and employs two extra valves.

The Marconi 874 (fig 6) is very similar to the Ekco PB189, V3 a D63 double diode as a Foster Seeley discriminator driving V4 a DH63, the audio amplifier triode, this is the interesting bit as this triode doubles up as a DC amplifier



The Controller fitted

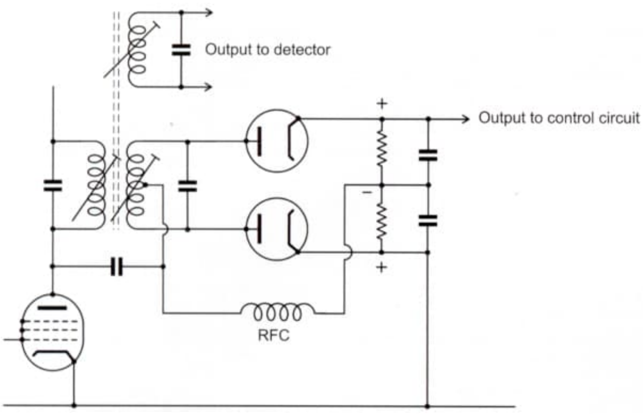


Fig. 4a: Foster Seeley discriminator

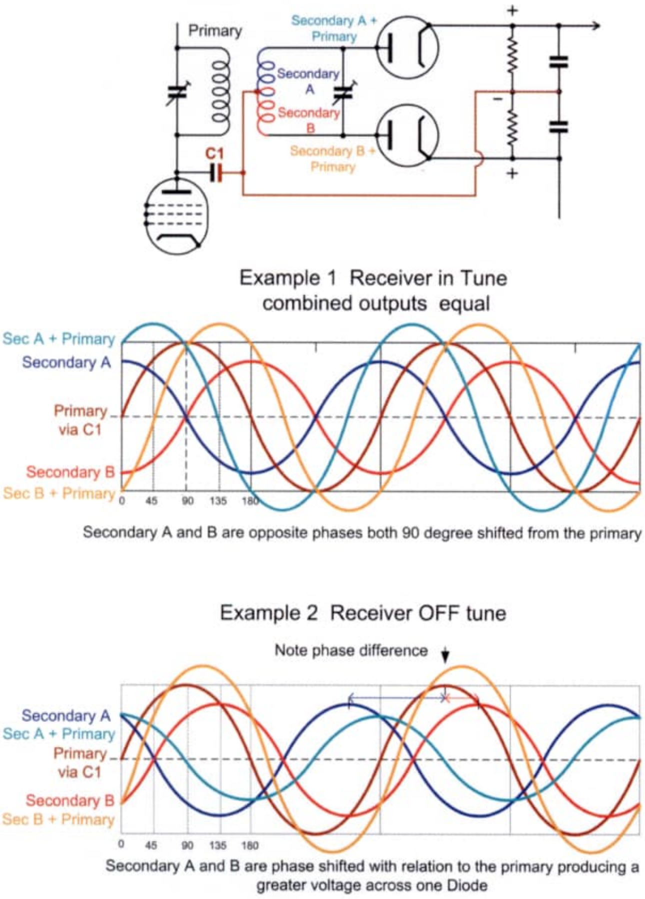


Fig. 4b: Foster Seeley discriminator Phases

oscillator controller, in this AFC circuit the discriminator and controller are both inductively coupled and only requires one extra valve, the simplest of the designs I've seen.

The Murphy A28C (fig 7) uses a capacitively coupled, double tuned circuit discriminator V6, a V914 double diode, driving V3 a ACSP1 an inverted Miller reactance pentode, in this circuit the control voltage is fed to the suppressor grid of the controller and this reactance valve is directly coupled to the local oscillator using the reactance of the valve to vary its frequency. This set employs two extra valves.

The McMichael 382 Motor Tuned Nine (fig 8), uses quite an elaborate circuit employing three extra valves. An inductively coupled extra IF amplifier valve V6 an ACVP2 to drive a Foster Seeley discriminator, V8 a V914 double diode. This also drives V7 a V914 double diode, the AGC detector, the discriminator output is fed to the suppressor grid of V5 an ACSP1 an inverted Miller reactance valve directly coupled to the local oscillator.

The RGD Model 1015 (fig 9) another elaborate circuit employing four extra valves if you include the tuning indicator driven from the discriminator. A capacitively coupled extra IF amplifier V4 a VP41, driving a Foster Seeley discriminator V8 a DD41 double diode, the control voltage is control grid coupled to the reactance controller, an SP41 pentode, directly coupled to the local oscillator.

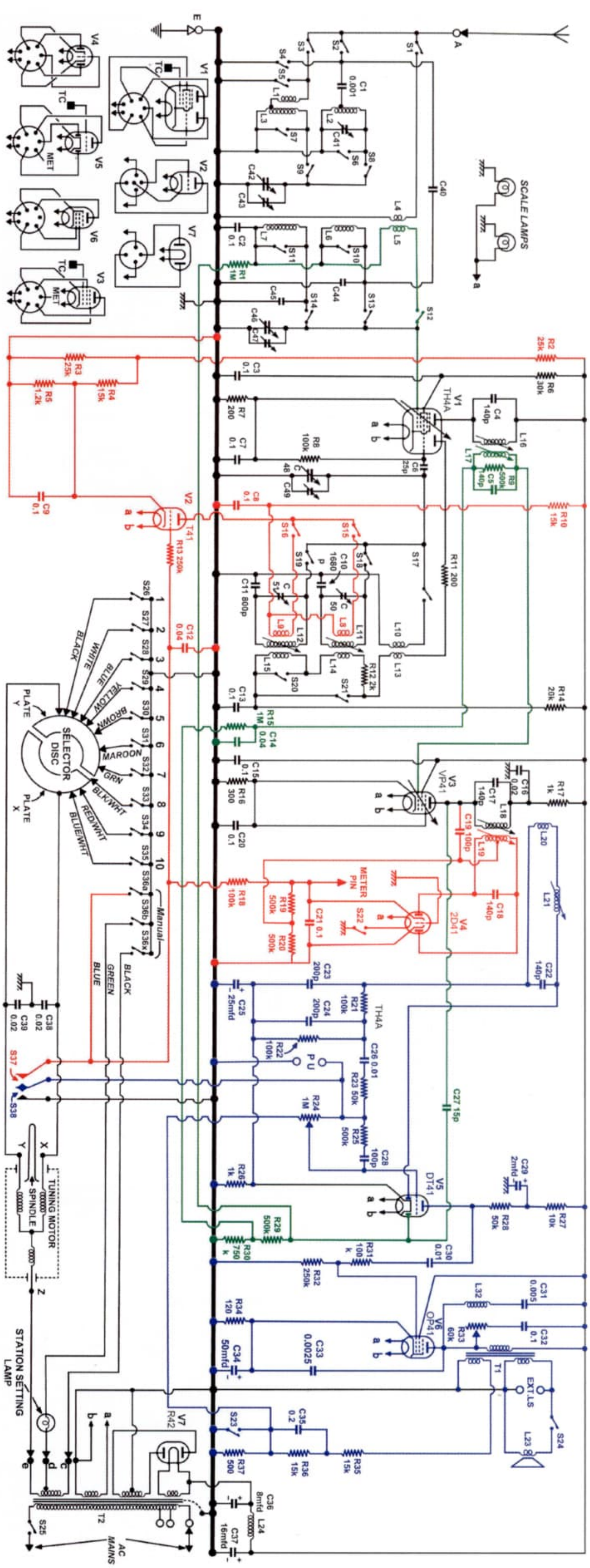


Fig. 5: Ekco PB 189

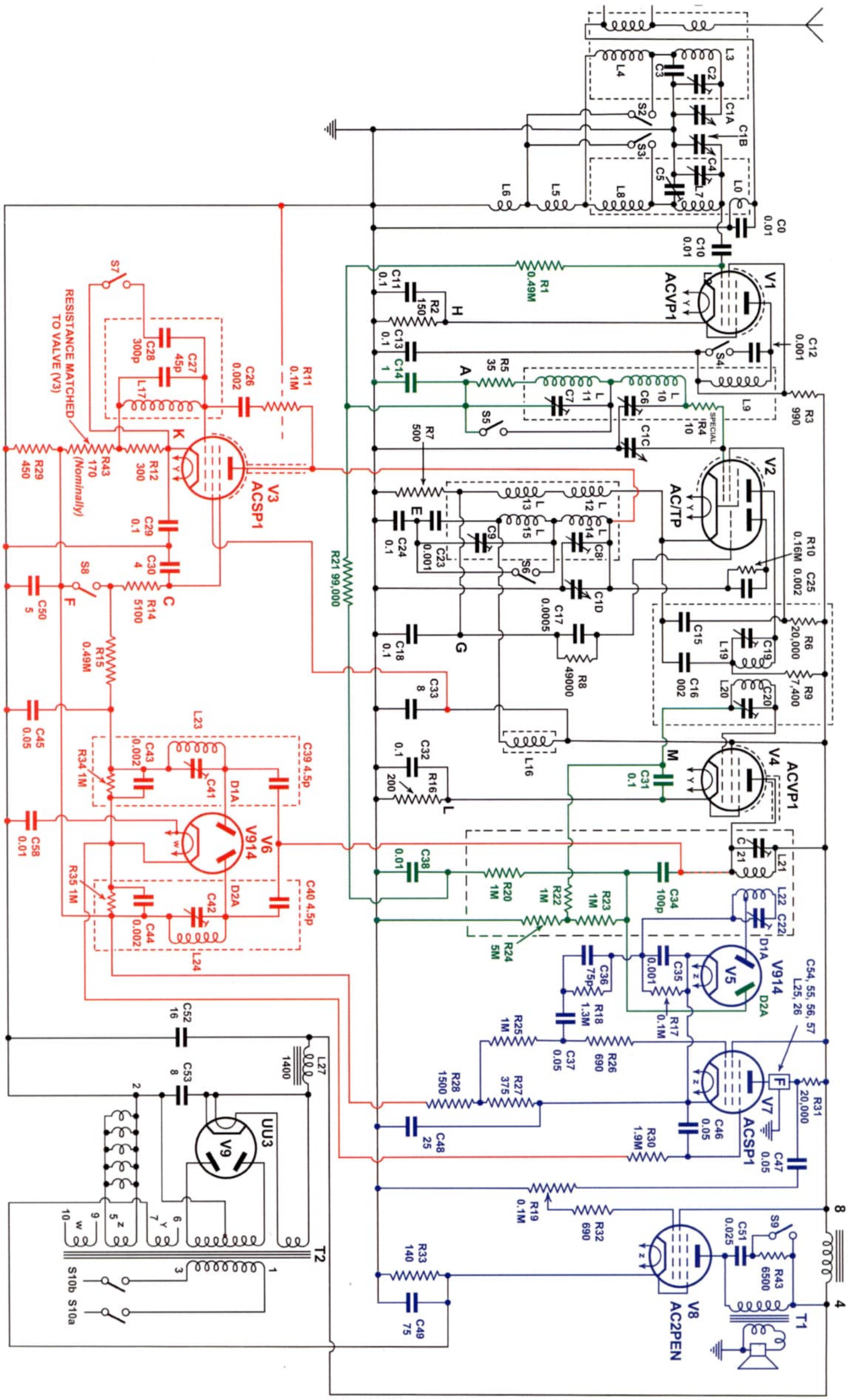


Fig. 7: Murphy A28C

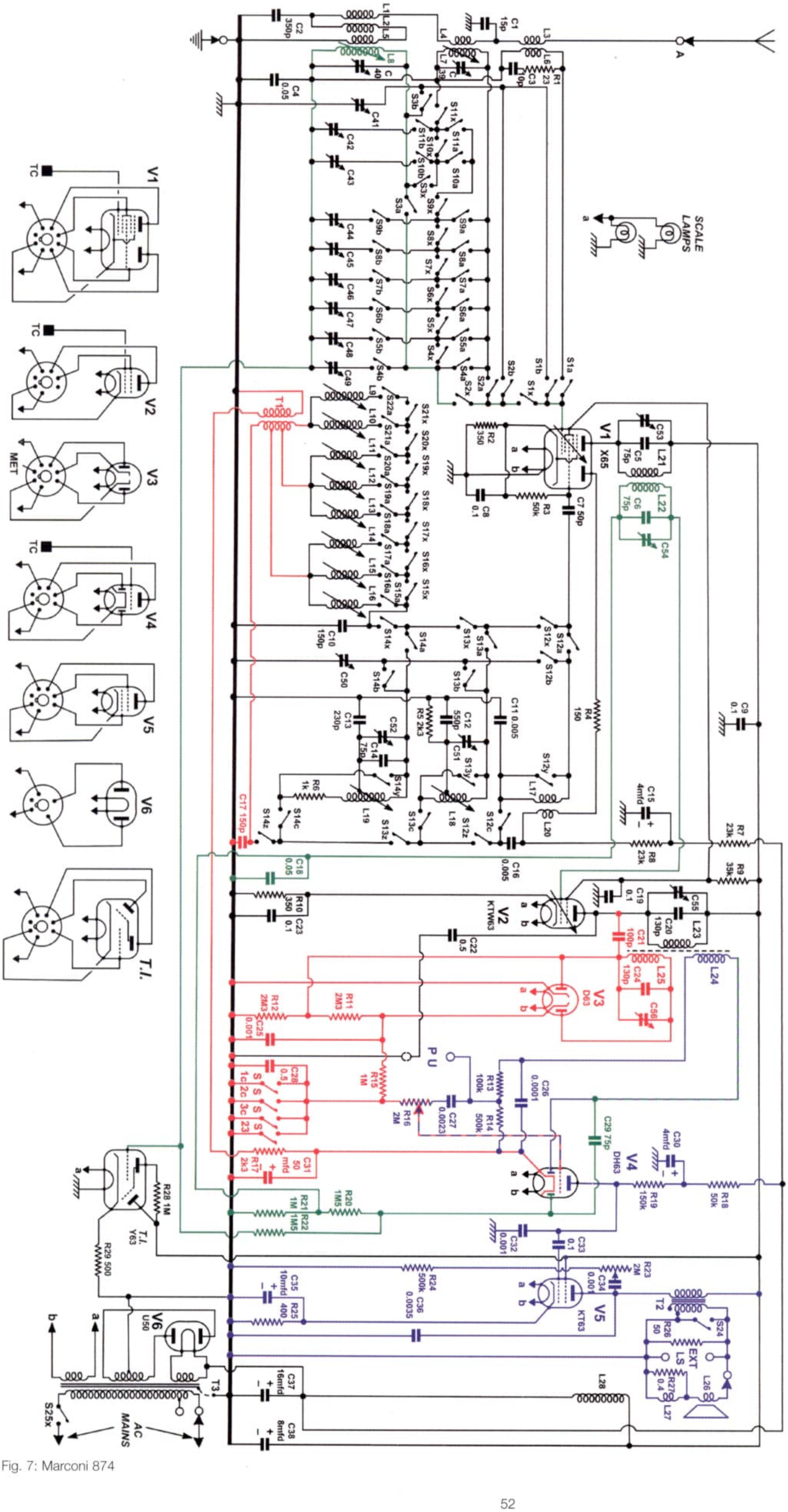


Fig. 7: Marconi 874

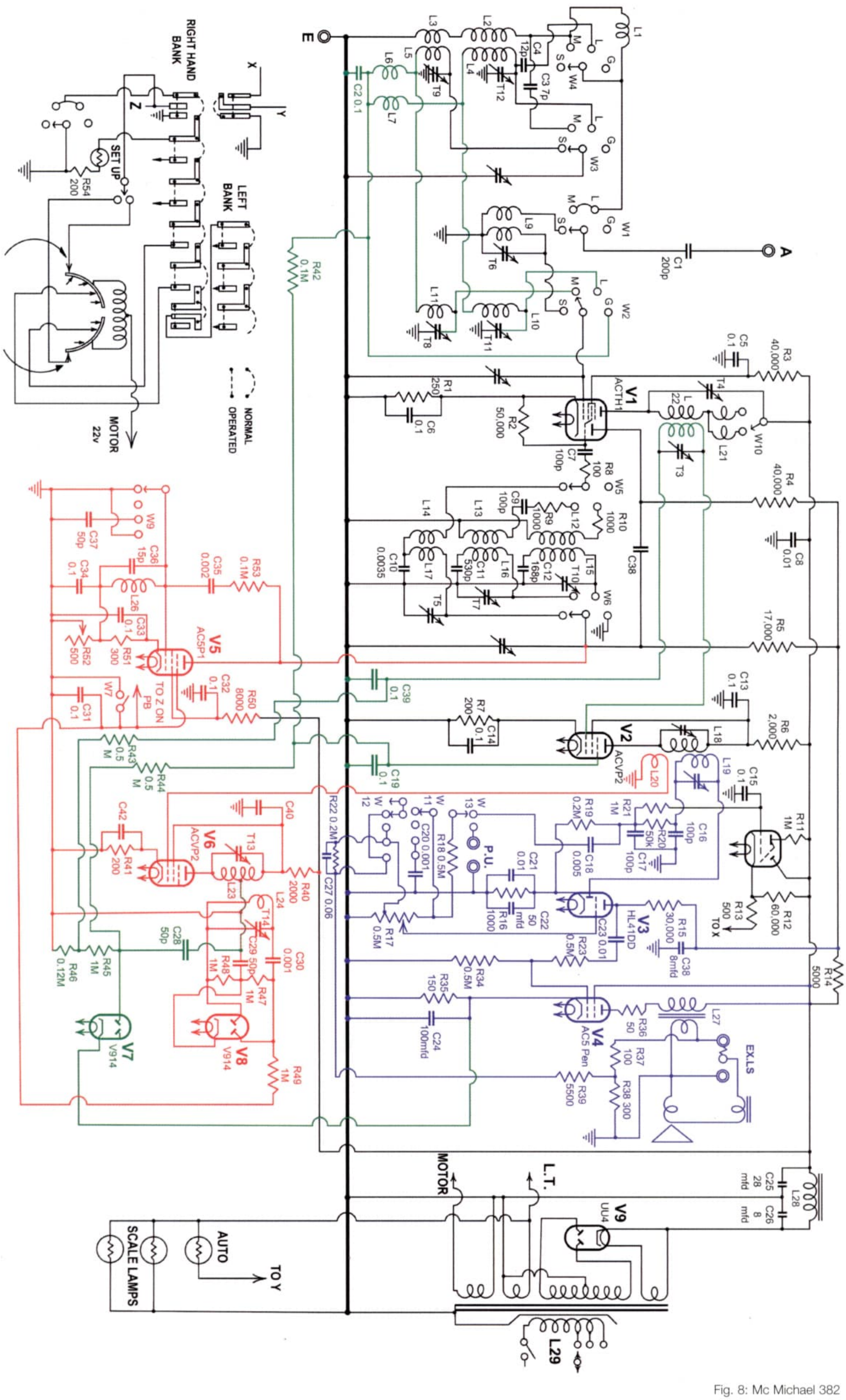


Fig. 8: Mc Michael 382

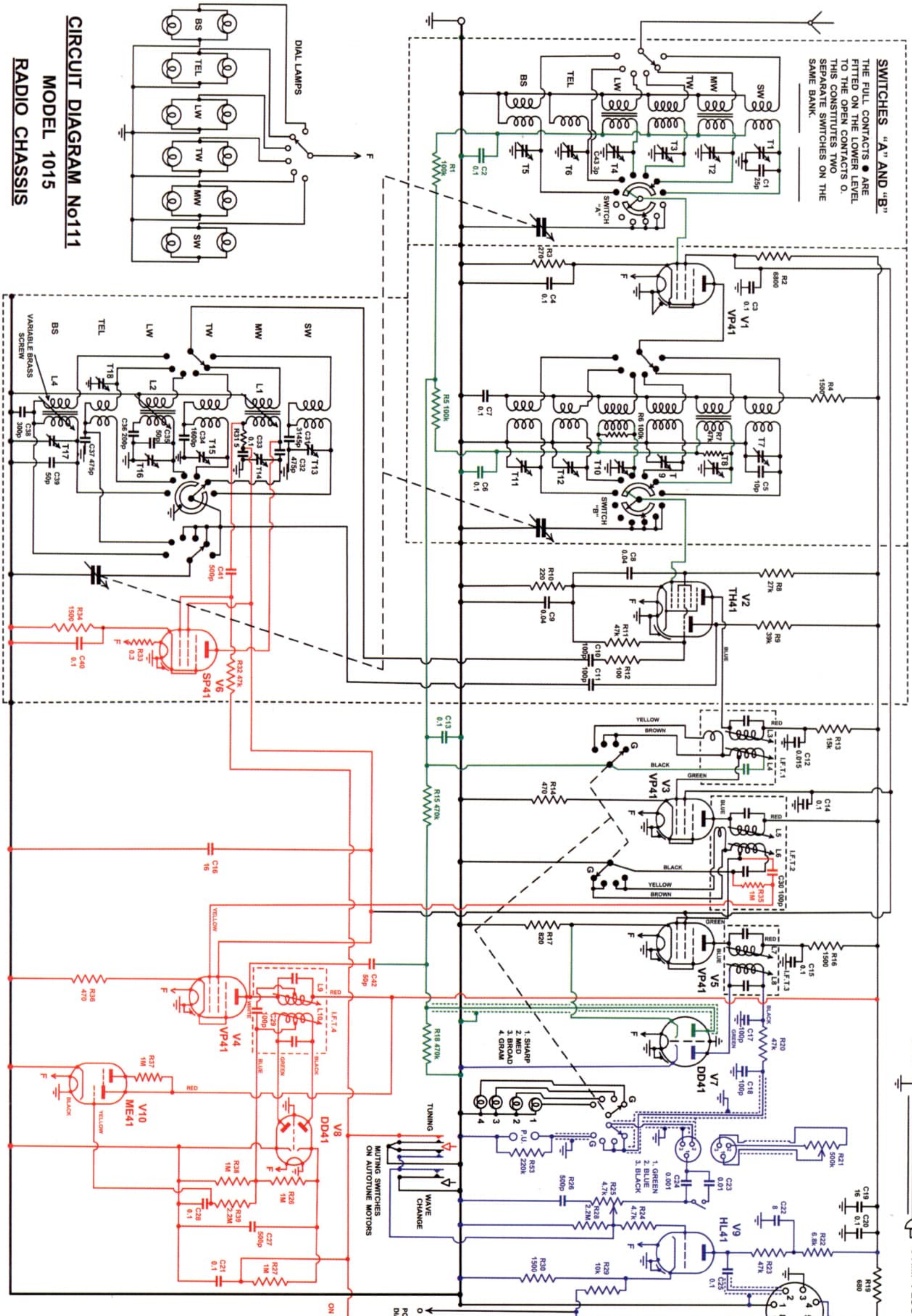


Fig. 9: RGD 1015

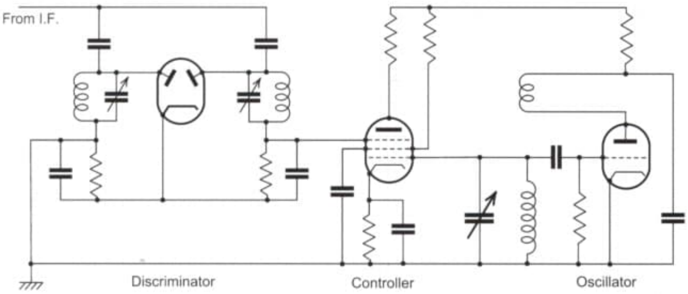
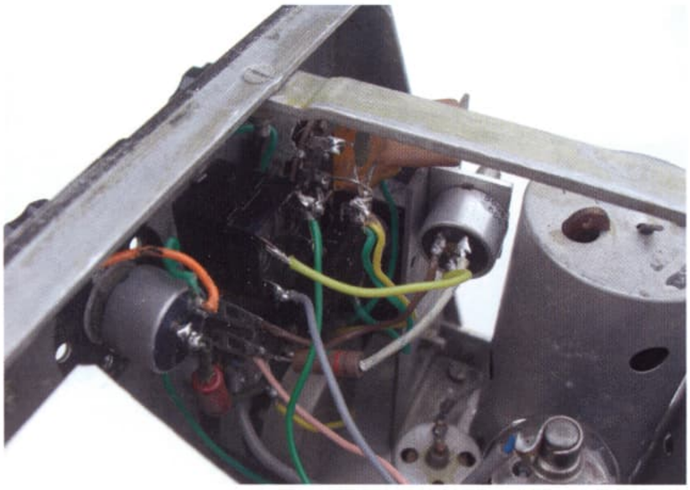


Fig. 10: Miller Effect AFC controller


The Set Ref Pot

The AFC switch in place

Using the capacitively coupled discriminator circuit of the Murphy A28C, I built a discriminator using a salvaged standard 465 kc/s IF transformer and a couple of silicon diodes, I did a few bench tests with a signal generator adjusting one coil 10 kc/s above and the other 10 kc/s below 465 kc/s and the discriminator worked quite well, with the coils adjusted 20 kc/s apart there was very little interaction between the two coils, the R1155 set I'm going to modify has an IF frequency of 560 kc/s, this required removing thirty turns off of both of the coils, this was done five turns at a time until I reached 560 kc/s and then basically tuned the coils to 550 kc/s and 570 kc/s ready for fitting into the set.

As the link between the discriminator and the control valve is a DC voltage, I decided that I would build and test both circuits separately, reading the output from the discriminator on a high impedance volt meter and adjusting the tuning via the control valve using a DC voltage across a pot. The object was to get both circuits working satisfactorily and then interface these two cribbed circuits together.

Before I could start I needed to find space for two extra valves in this already extensively modified set, (see Bulletins Winter 2010 and Autumn 2013 for the full story), I needed also to re-arrange other modded parts of the set to accommodate an extra heater transformer, the existing transformer heater winding already overstretched feeding two dial lamps and an extra diode for the AGC detector and I wouldn't ask it to drive the two extra valves for AFC as well.
I removed the internal speaker as the set sounds so much better with a large external speaker (one of the previous mods) and replaced the missing chassis in its space, this afforded lots of room for rearrangement for the extra heater transformer and valves. I moved the 6V6 output valve from its position in place of the original V9 (DF meter driver), and re-sited it in the original V2 position (part of the DF RF amp and switcher), this frees up the old V9 valve holder for the 6H6 double diode discriminator valve I'm going to use as close as possible to the last IF amplifier. I added a bracket to the end of the coil box and fitted the added IF discriminator can and a tag strip in the space provided by the removal of the DF components, this was in just the right place under the V9 holder for wiring to the discriminator and anode connection to the last IF amp. With the wiring complete I ran through a full IF re-alignment with the discriminator now capacitively coupled to the final IF anode, adjusting the upper discriminator coil for max output at 570 kc/s, then the lower discriminator coil to 550 kc/s, this gave me a voltage swing of between -20 volts above the IF and -3 volts below, with around -11 volts when on tune. (this was with one side of the discriminator output connected to ground) I was very pleased with this result and with the discriminator working well with a good output, I'll finalise the tuning later when I get a controller up and running.

Next, a controller and scaler stage, using a 6J7 pentode wired as a Miller effect controller, using the suppressor grid (grid 3) for controlling the gain of the valve and the control grid (grid 1) for the capacitive change connected to the local oscillator grid circuit at the tuning capacitor, as in fig 10, this experimental valve fitted above the tuning capacitor for the shortest connection to the local oscillator on C82 the tuning capacitor. Only having a basic circuit of this technique from one of my reference books (ref 2), I used pots to set voltages and biases to this valve with a lot of guess work based on other circuits. unfortunately after a lot of experimentation this circuit failed miserably, changing the voltage on the suppressor grid made very little difference to anything and no change in the capacity of the control grid, the only variation was by varying the cathode voltage, this made only a very small change, after much experimenting I eventually abandoned this idea.

The next step was to try a reactance valve. This circuit uses capacitive feed back from anode to grid applying a 90 degree phase shift and making the valve behave like a inductance. I suspected this method may take a lot of getting right and why I had avoided it on the first trial. In the interests of keeping it simple I decided to use a 6J5 triode (one of my favourite valves, I had a lot of fun with this electronic building block in my youth), this will be capacitively coupled to the anode of the local oscillator, similar to the circuit of the RGD 1015, this required a circuit change, swapping the inductive - capacitive coupling between the local oscillator and controller, in the RGD the local oscillator has an resistive anode load and is capacitively coupled to the controller via a 100pf capacitor to the controllers inductive anode load, the R1155 has a local oscillator with an inductive anode load so I'll give the controller a resistive anode load and couple it in the same way with a 100pf capacitor. Early experiments looked promising and just needed tidying and a few fine adjustments.
The 6J5 is mounted horizontally above the tuning capacitor as was the previous failed experimental controller, this gave the easiest and shortest route through the gap in the chassis behind the tuning capacitor to the local oscillator anode, I connected it to the MW tag on the wave change switch FS zr, the closest point, very convenient as I only want AFC on medium wave. The grid was connected to a potential divider via a 1 Meg resistor, the divider a 1 Meg pot across the HT + and - rails, this with a series resistor and decoupled to give my pot a swing between about +/- 30 volts. On test the reactance valve worked very well and I could get a swing of frequency change of around 20 kc/s at the 1500 kc/s end of the tuning scale, just the job. The reactance valve stopped working at each end of this frequency range as the grid voltage approached 0v or its -15 volts cut off, so I set the mid point to -7 volts with the set in tune.

Next, to interface it to the discriminator. The final fine tuning of the discriminator coils was done with the discriminator isolated from ground, the coils were balanced to give an output voltage of 0 volts on tune and gave around +/- 15 volts at 10 kc/s each side of the selected frequency when off tune. The easiest way to match this to the controller is to pre-bias the discriminator, so the minus side of the discriminator was connected to the -7 volts reference pot used for the controller tests, the discriminator now gives an output of -7 volts on tune. On test I found the station tuned was permanently just off tune through around a 20 kc/s sweep through the selected frequency, the AFC appears to be working but in reverse, keeping the station just off tune, this was easily remedied by reversing the output connections from the discriminator, the AFC then appeared to be fully operational, I couldn't believe it was this easy. I found adjusting the discriminator coils following the DC output voltages using a high impedance voltmeter (DVM) quite easy, the signal generator and a scope waiting in the wings unnecessary.

The final task, switching it out for initial tuning. While the controller is coupled to the local oscillator it applies a small capacitive load, open circuit the coupling and the tuned frequency will shift, so as in the commercial examples the disconnect will have to be between the discriminator and the controller, as the test bias pot was set to -7 volts and the discriminator pre-biased "in tune" using the same -7 volts, the easiest way is to just switch the controller input between them, this very simple system worked well. I used the original Filter switch on the top left of the front panel as it's the closest to the controller valve above the tuning capacitor, this was being used as the audio filter on/off switch (a previous Mod), I replaced the three position audio filter tone selector switch with one with an extra position so the audio filter could be switched out, freeing up the filter on/off switch, then re-labelled the filter switch "AFC". I fitted a bracket to the audio filter panel close to the AFC switch for the "set bias" -7v pot, this was wired to the -HT rail via a limiting resistor giving a range of 0 to -15 volts.

A few checks before a good soak test, I tuned the set into a station in the high frequency end of the band (1548 kc/s) and switched out the AFC, then detuned to a point above the station frequency where the station was almost lost, about 5 - 6 kc/s, then switched the AFC back in and it captured very nicely and bought the station back in tune, I did the same test below the station frequency and again it passed with flying colours, the same test then made on another station at the other end of the band (700 kc/s) and again all was well although I found the range reduced at this end of the band, my initial notes on the tuning drift on the R1155 indicated the drift was a lot less at this end of the band so this won't be a problem. I then reduced the aerial signal level to check for AFC tuning shift with signal strength, a couple of meters of wire for the aerial, the signal strength meter read about 20% of the deflection obtained on full aerial, this made little or no difference to the action of the AFC it was still working. Not using a limiter stage (neither did the commercial examples), I had hoped the AGC would maintain a reasonably constant level of IF signal and it appears to perform better than expected. I did a few later experiments on directly coupling the controller to the oscillator removing the anode load resistor and the 100pf capacitor with the controller valve supplied from the oscillator anode as in some of the commercial examples, but I found this made the controller less efficient and a bit less linear in operation, so was put back to my original circuit. I also considered replacing the 6J5 with a pentode valve but as I had now achieved my objective I left well enough alone. The set is now back in its place and so far has been working very well over the past winter months, job done!

I've no doubt this basic AFC circuit may need some refining in the future after a more extensive field test, but with the AFC working beyond the range of the actual tuning drift on this set and my expectations, I'm very happy with it keeping my preferred station permanently in tune and no longer requiring an occasional nudge to get over the stiction of my mechanical device, now retired back to the junk box.

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   Part 2. 19 March 1938 page v (back of KB 660)
   Part 3. 26 March 1938 page viii (back of Ultra 150)
   Part 4. 2 April 1938 page v (back of Beethoven P202)

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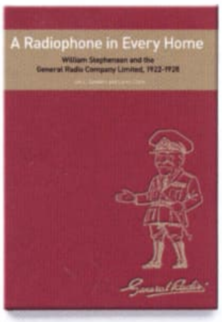
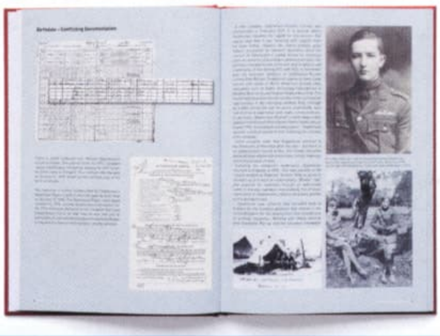
by Ian L. Sanders and Lorne Clark, with foreword by Jonathan Hill. Published by Loddon Valley Press. ISBN 978-0-570773-0-0.





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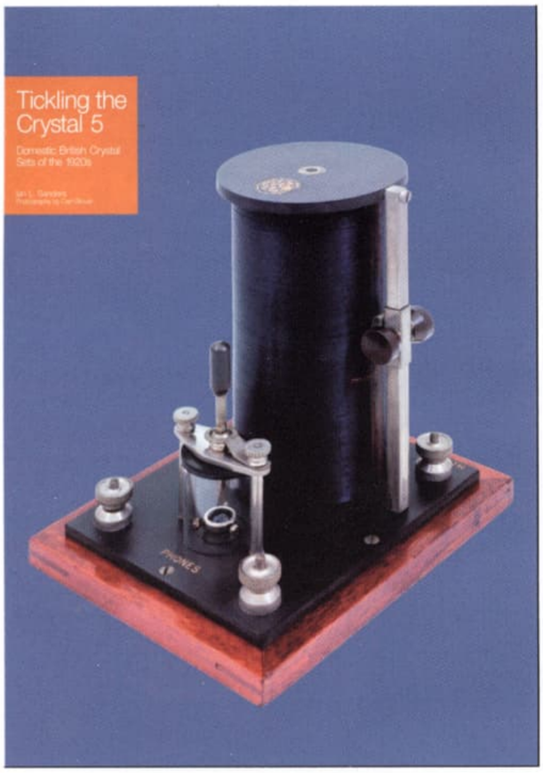

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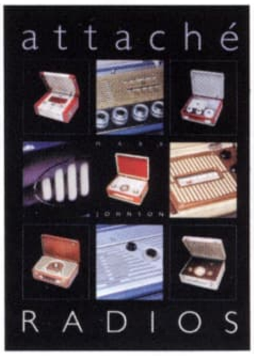

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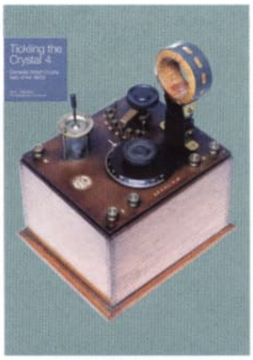

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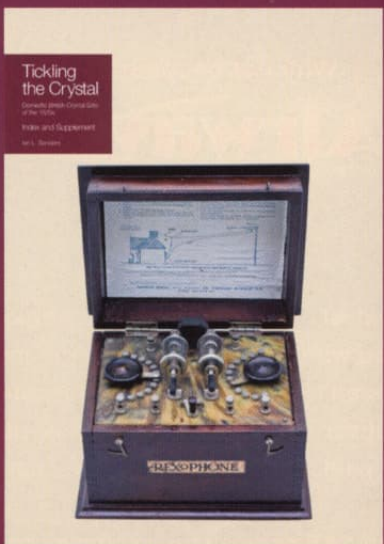

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12 - 6pm The Vintage Wireless and Television Museum, West Dulwich
June 7th Meeting at the Cinema Museum.
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See advert in Bulletin insert for further details.
July 5th Royal Wootton Bassett
August 2nd Punnetts Town
September 13th Murphy Day at Mill Green Museum
September 27th Harpenden
October 4th AudioJumble
November 1st Golborne
December 6th Royal Wootton Bassett

GPO Numbers

Martyn Bennett is the custodian of the BVWS GPO Registration Numbers list. As many members know, the project of assembling this list was started in the early days of the BVWS and was carried on by the late Pat Leggatt. Members are strongly urged to help build the list, whenever they get the opportunity, particularly as it is something that will help with the identification of vintage wireless in years to come. The list is by no means complete and the GPO no longer have a record of the numbers granted to wireless manufacturers. The BVWS Handbook contains the current listings - one in numerical order and one ordered by name. Please let Martyn have any additions, or suggestions for corrections, by mail or over the phone.

Martyn Bennett, 58 Church Road, Fleet, Hampshire GU51 4LY telephone: 01252-613660 e-mail: martyb@globalnet.co.uk

The British Vintage Wireless and Television Museum:
For location and phone see advert in Bulletin.
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NVCF: National Vintage Communications Fair
See advert in Bulletin. www.nvcf.co.uk
Wootton Bassett: The Memorial Hall, Station Rd. Wootton Bassett.
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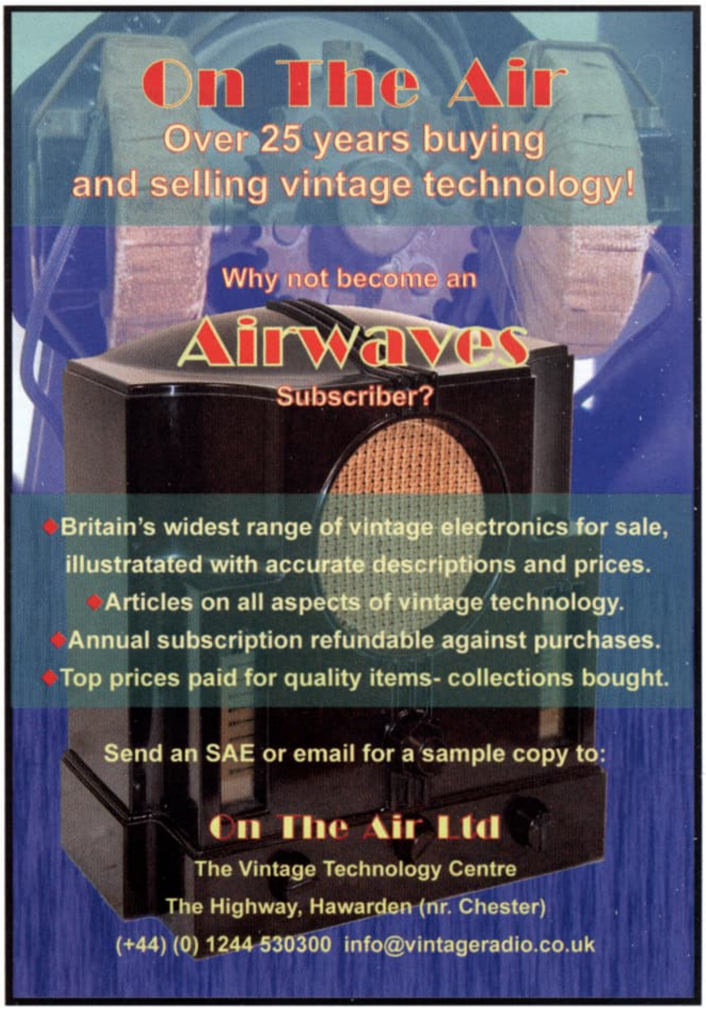

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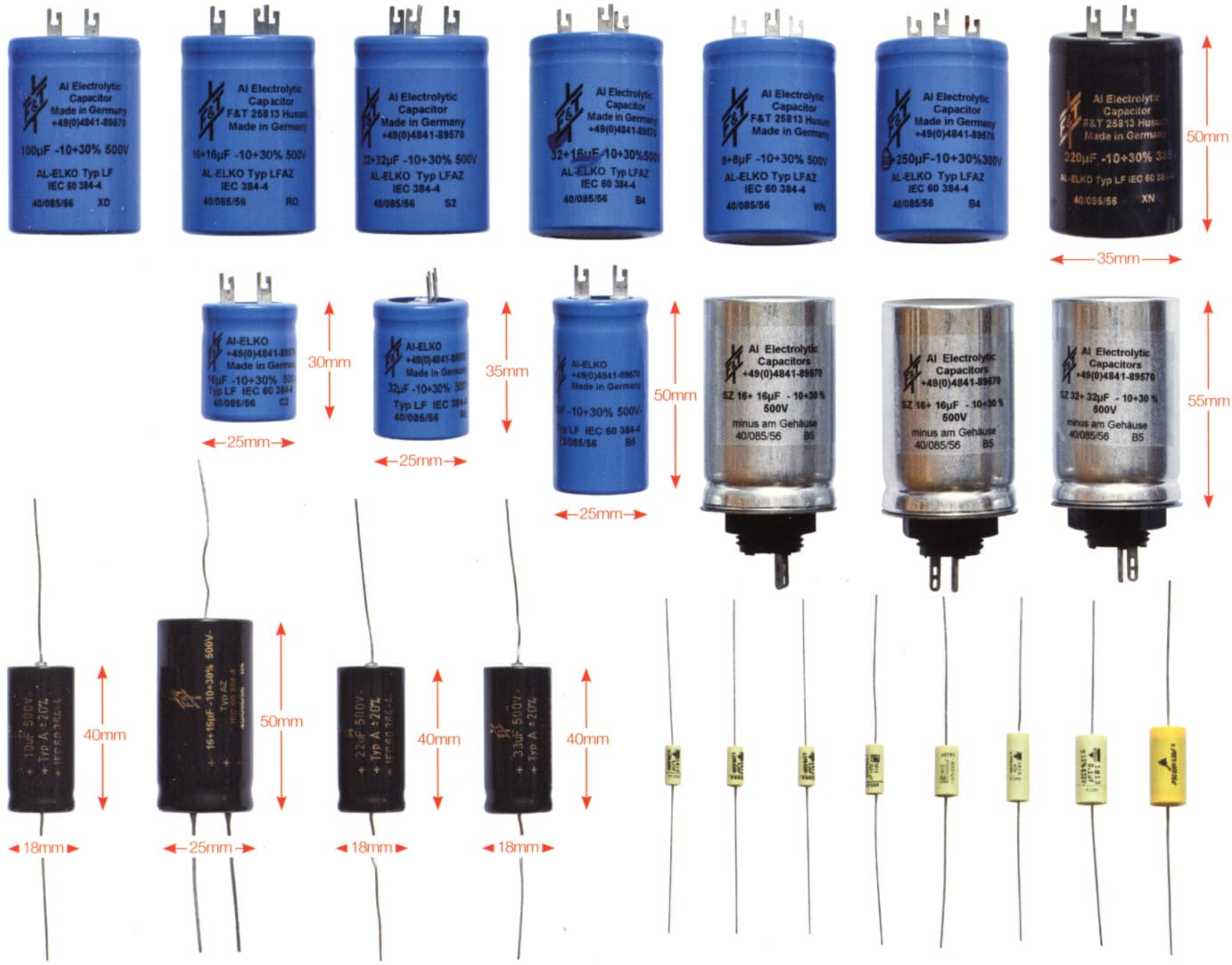

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